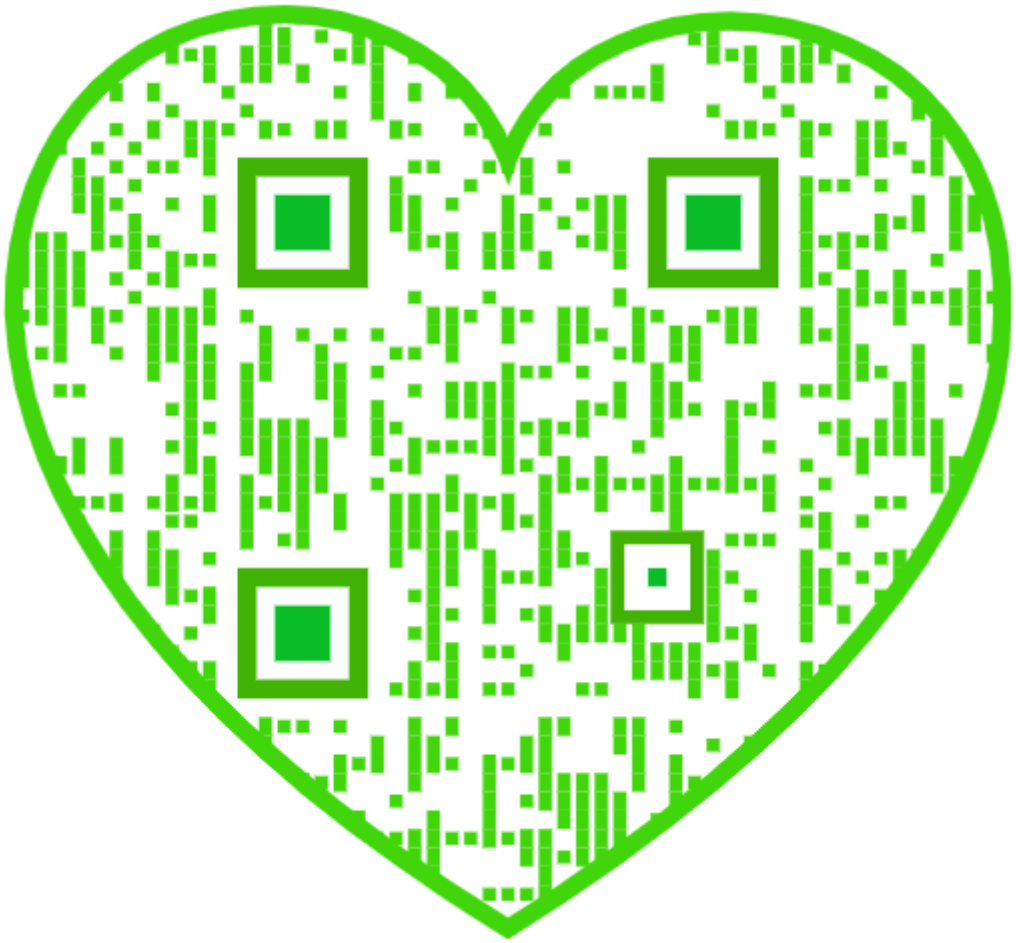
S

PRACTICAL FARMING

by

SAMUEL W. ALLERTON



Class S 5 1
Book .A 4 o
Copyright No.

COPYRIGHT DEPOSIT.

Chicago, September, 1907.

Samuel W. Allerton.

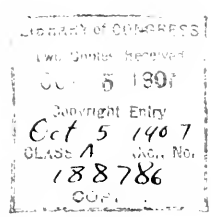
PRACTICAL
FARMING

A Treatise on Present Farming Conditions and How to Improve Them

BY

SAMUEL W. ALLERTON

RAND, McNALLY & COMPANY
1907


LIBRARY OF CONGRESS
Two Copies Received
OCT 5 1907
Copyright Entry
Oct 5 1907
CLASS A XXc., No.
188786
COPY.

Copyright, 1907, by Samuel W. Allerton

"He who showeth his neighbor how to better existing conditions is a public benefactor."

Preface

Coming from Nebraska recently, my son said to me, "Father, you should write a book on farming, for you have given me lessons in farming, and I raise double the amount of oats and corn the farmers do in Illinois, and my land is no better than my neighbors'. If you can write a book and show the farmers how they can improve their systems of farming, you will be a great public benefactor. While traveling in the Old World, particularly in India and China, I saw the table lands worn out and abandoned. Will this not happen in our country unless the farmers change their systems of farming and study how to improve their land? If you could show the farmers how to improve their land in a practical way instead of making it poorer, wouldn't it be the best work of your life?"

Influenced by this suggestion, I submit my ideas. Having lived on a farm for twelve years—from the time I was fourteen years old to the twenty-sixth year of my life—having plowed, mowed, cradled, and done every kind of work connected with a

farm, and having owned and operated farms practically all my life, I feel that this experience gives me some knowledge of farming, and enables me to present some practical ideas to those who may be interested in my conclusions. I notice that the rich farmers are the men who have systems and keep their land in a high state of cultivation. The farmer with no system and land worn out is the poor farmer.

I feel that it is the duty of every man who has had any experience in cultivating soil to give publicity to his efforts and progress along this line, and thus add to the success of the American farmer.

It is a well-established fact that Illinois, as a corn State, is the richest natural body of corn land in the United States. Ohio, Indiana, Illinois, Iowa, Wisconsin, Nebraska, and Missouri constitute the corn belt. All are great states and naturally very rich, productive land. We see, however, that the great State of Illinois averages only about thirty-three bushels to the acre in a good corn year. What does this indicate? That the land has not been properly cultivated and kept in a suitable condition to raise large crops of corn.

Every farmer knows that his land is steadily being reduced in fertility, and is wondering what can be done to restore it. I met some farmers last year who lived east of Bement, on the Wabash road, who said they raised only thirty bushels of corn and oats to the acre. They raise corn one year and oats the next year; this they call rotation of crops, but they return nothing to the soil, and wonder why they can't raise as big crops as they used to. This is very rich land—no better in the State of Illinois—and should raise sixty bushels of oats per acre and eighty bushels of corn per acre, if they would rotate their crops, keep part of it in grass; keep some live stock—cattle, sheep, or hogs—and use some phosphate.

SAMUEL W. ALLERTON.

Chicago, September, 1907.

GRADUALLY KILLING THE LAND

Every man familiar with raising corn knows that eighty bushels per acre can be raised as easily as thirty bushels per acre, if the land is properly treated. With all the big crops we raise—corn, oats, wheat, rye, barley, and flax—under our present system of general farming (there are exceptions), we are reducing the production 2 per cent yearly. Professor Hopkins of the University of Illinois claims that the great rich State of Illinois will be a desert within one hundred years unless we change our system of farming. How does he prove it? He has a plot of ground which he has planted to corn for the last twenty-eight years. In a few years it will be exhausted, and will raise neither corn nor clover. He estimates that it will take forty-eight years to exhaust the soil of phosphorus. He has two other plots, and raises corn on one and oats on the other every other year. This is the system that most of our farmers

follow—plow their oat stubble in the fall, plant corn the next year, and sow their oats on the corn stubble.

These two strips are as fine land as there is in Illinois, and yet raise only thirty bushels of corn per acre and thirty bushels of oats, and lose about 2 to 3 per cent every year in producing a crop, and, obviously, in thirty years will be exhausted. He has other plots where he plants clover one year, corn the next year and oats the third year, and in this way raises sixty bushels per acre; he has still other plots where he plants clover, corn, and oats in rotation, *with fertilizer*, and raises ninety bushels per acre. These facts have been demonstrated by the State Agricultural Society at Champaign. These being facts, has not the time come when the farmers of the great Northwest should do a little thinking and study how to improve their land?

In the State of Maine, where the soil is of a very poor quality, they raise a greater quantity per acre than we do in the great State of Illinois. These facts must certainly convince every intelligent farmer

that we must return something to the soil, and that we cannot constantly reduce it without serious consequences. Probably 70 per cent of the corn land in Illinois has been cultivated for the last thirty years in this way—oats one year, corn the next year, with really nothing returned to the soil.

FIVE-FIELD SYSTEM

Take the average farmer who has 160 acres of land. He may raise about seventy acres of corn and seventy acres of oats. His gross sales will not be much over $1,200. He should divide his 160 acres into five fields of thirty acres each, allowing ten acres for a house, barn, and garden; keep 100 good ewes; have sixty acres in corn, sixty acres in grass, thirty acres in rye or oats; keep twenty good brood sows, raise 100 pigs, and arrange to have the pigs come in the last of February or the first of March. In this way his land would be kept in a rich state and he would be sure to raise seventy-five bushels of corn per acre (unless he had an excessively dry July and August), and he would probably raise about thirty bushels of rye to the acre.

It would be better to sow rye, because he would be sure to get a better set of clover than after oats. If he raised 100 good market lambs, they would be worth $500; his wool should bring $150; he should raise 100 hogs to weigh 200 pounds, worth $1,200; his rye crop would be worth $400 at least, and he should raise about 4,500 bushels of corn, half of which he would feed to his hogs and horses, leaving about 2,000 bushels to sell, which would yield $800 more. This would make his gross sales amount to $3,050, and his land would be growing richer every year instead of poorer, as it is now. His corn fodder, properly cared for, would be much better feed for his stock than hay. He would have sixty acres in grass, and he could divide off ten acres, with a temporary fence, for a meadow.

CROP ROTATION

Hon. Secretary Wilson says we can keep our land up by the ordinary rotation of crops, but Professor Hopkins says not. I have always been of the same opinion as Secretary Wilson, that we can keep our land

up by the rotation of crops under the five-field system, but I have watched this rotation of crops and am now convinced Professor Hopkins is right. I find the straw gets weak and lodges easily; after a few years the corn is not plump, the ears are not sound and firm as when we use phosphate or potash, but with the five-field system *and phosphate*, we would restore our land to its natural fertility and keep it in a state of high cultivation.

FERTILIZERS

Professor Hopkins advises buying Tennessee phosphate rock for fertilizer. Some of our farmers have used it, but can't really see any benefit from its use, but that is because they don't use it properly. It should be sown on the green clover or green weeds and plowed under or mixed with manure and plowed under. This affords acids enough to liberate the phosphate from the rock. Therefore, any farmer dividing his farm into five fields, two in pasture, one in rye, and two in corn,

utilizing all his manure with a moderate amount of phosphate or Tennessee rock, would improve his land every year, and, in a few years, raise more corn on sixty acres of land than he now raises on 100 acres, and raise a very much larger crop of rye, oats, or wheat. I consider this system well adapted to Illinois, Iowa, Ohio, Indiana, Wisconsin, and Missouri. Traveling through the old world, China or Japan, you find that when they market their products they always take something back to fertilize their soil. Necessity has taught them this, and should we not begin to think of *our* situation with this fact before us—that Illinois raises only thirty bushels of oats and thirty bushels of corn per acre. This is a fact that we cannot ignore. I know that farmers sometimes get into a rut, and it is hard work for them to change, but the only thing to do is to recognize these mistakes and correct them. Don't try to plant so many acres, but raise more corn on fewer acres.

TESTING COMMERCIAL FERTILIZERS

It is very simple to make a test to know positively the value of the different kinds of commercial fertilizers, by taking a strip of land through your field and treating it with fertilizer. Of course, you could take several strips and try the value of all commercial fertilizers. Naturally, there is a great variety of soil in the different states, and generally the farmer knows what is the best crop to raise on his land, but take the great states I have named, and corn and oats are the best products. Nature's law has arranged things so that we can keep our land in a state of high cultivation by the proper rotation of crops and applying phosphate. I have one farm on which corn was raised on clover sod and yielded 82 bushels per acre. The next year this same land was again planted to corn and yielded only 56 bushels to the acre. A farmer adjoining me, with as fine land as there is in the State of Illinois, has corn that will yield only 25 bushels to the acre. He is one of the farmers with the system of oats one year, corn

the next year, and never returning anything to the soil.

Hon. James Wilson, Secretary of Agriculture, says that corn cobs are of no use to any man. He is generally right, but I disagree with him in this. The cobs and the stalks have as much phosphate as the corn. Stalks and cobs should never be burned. As good a piece of corn as I ever saw was raised on land covered with cobs. In the old states they husband their manure with great care. We, in the West, burn our straw and stalks, and put little value on the manure, which is a mistake. It should all be saved and spread on the land and plowed under.

TENNESSEE PHOSPHATE ROCK

Professor Hopkins has great faith in Tennessee phosphate rock as a cheap fertilizer. I have not yet had experience enough to state its true value. I see the Agricultural College of Ohio claims that when it is properly mixed with manure it is worth $50 per ton, as it will increase a crop of corn that much.

PROVING THE VALUE OF FERTILIZERS

Take one or two barrels and saw them in two; get some sand; wash it and fill each half barrel with this sand. If mixed with the proper fertilizers you can grow big corn. This test should certainly satisfy any farmer of the value of commercial fertilizers, for the corn could not grow in this sand without fertilizers, and should convince the farmer of the importance of buying the proper fertilizers for his soil.

CHICAGO'S MISTAKE

There is no doubt in my mind but what Chicago will realize in fifty years one great mistake it made. We should have dug a tunnel under the city for sewerage and saved the fertilizer. We would then have had drainage for the city, and fertilizer to sell to enrich farm lands.

JAMES J. HILL

James Hill has given the American people warning of over-confidence in believing that our land will always produce great crops without greater intelligence in farming. Hill is a thinking and an observing man.

He sees the rich valley of the Red River gradually being reduced in fertility; that they now have to summer fallow their land, and that it takes two years to raise a crop. In the early history of California they sowed wheat, and it would shell out and they would have a volunteer crop, but now the land has to be summer fallowed, and it takes two years to raise a crop. Hill sees the necessity of arousing the farmer to realize that he is gradually wearing out his land. It is only a question of time when the farmer will be asking himself, "Why can't I raise such crops as I used to?" Prof. Hopkins tells me he receives thousands of letters from farmers making this inquiry. His answer is, "A better system of farming by rotating crops and applying phosphate to the soil," phosphate being the most important element in raising a good crop of corn, potatoes, oats, barley, and clover. England, France, and Germany buy 2,500,000 tons of phosphate yearly. Surely they realize its value or they would not continually increase their demand. Shall we remain dormant and allow them to

take from us that which our lands are hungering for? This is a serious question for our farmers to consider.

WILFUL WASTE MAKES WOEFUL WANT

There is no city in the history of the world that has grown, in a short time, so vast in population, wealth, and importance as the city of Chicago; but no city has tributary to it so many acres of productive land. Illinois, Wisconsin, Iowa, Minnesota, Nebraska, and Missouri abounded in fertile soil. All the farmer had to do was to break these rich rolling prairies and he had a garden of the richest soil in the world. Crops grew in great abundance. We can feed the world from these lands, and yet, in shipping millions of bushels of grain, we are gradually taking from the soil millions of tons of phosphate and other elements that made our soil so productive. No nation has so vastly reduced its soil. The inventor and the enterprising manufacturer have made machinery to cultivate these rich prairies with great economy. In fifty years more, however, with this continual

debasing of your soil, without any thought of restoring it to its natural fertility, what will be the condition of the great Mississippi Valley that should be the empire of the nation?

Unless we study how to improve our lands, we will be hunting for bread to feed our own people. No question is of so great importance to the American people. How shall we restore our land and maintain its fertility? We know it has been reduced 30 per cent and is gradually growing less productive, but with the aid of scientific men practical farmers can restore it. How shall we arouse the farmer to realize the important position he holds, for the successful farmer is the basis of all our great industries. We have fine agricultural colleges, and yet 90 per cent of our farmers cultivate their land as they have for the last forty years. We read about the poor Russians starving because their land is worn out. We think this will never happen to us, but if we go through the southern part of the State of Illinois, where they used to grow fine crops of wheat on the rolling prairies,

the land abandoned to-day and selling at $18 to $20 per acre, we will realize our position. Take Central Illinois, the richest land in the world, and it will not raise half a crop. We read about Illinois raising on an average only half a crop of oats, and yet the farmers who cultivate their land properly have fine crops. We ship yearly 2,500,000 tons of phosphate rock to the old country when we need it at home. How can we arouse the farmer to buy these fertilizers and keep them at home?

IMPORTANT QUESTIONS

We have many great questions to solve in this country. The tariff question, for instance, which is simple within itself. If too high, gradually reduce it a percentage each year and let the manufacturer adjust himself to a lower tariff.

We have men who wish to run for President; clamoring for government ownership of railroads, which means a centralized government that will be more arbitrary than the Russian government.

The immigration question is of great importance; great numbers of foreigners coming to our land who don't understand the meaning of Liberty—individual rights with reciprocal duties. This question should call for the best thoughts of our people.

THE GREATEST PROBLEM OF ALL

Great as all these questions are, however, there is no question of so great importance to the American people as how to restore our land to its natural fertility and keep it in a state of high cultivation.

KEEP THE LAND UP

To be prosperous and successful, the farmer must study how to keep his land in a state of high cultivation, for if kept in this condition, he will raise a fairly good crop in a bad year. If his land is run down, of course he will raise a poor crop, and when his land gets poor, he will grow poor.

LACK OF TILING AND CROP ROTATION

Coming from Omaha, and riding through Eastern Iowa and Northern Illinois, I saw a beautiful country, but I know the corn will not average thirty bushels per acre.

Eastern Iowa and Northern Illinois need tiling, but I did not see a drainage tile factory anywhere in that district. No man could wish for a more beautiful country and richer soil. If tiled and farmed by rotation, all this land should raise 75 bushels of corn per acre. I saw no farm that seemed to be laid out with any regard to system of lots. The whole thing seems to be run on a haphazard, go-as-you-like-it plan. On any of these good 160-acre farms 30 cows could be kept by being soiled, as easy as 15 cows if pastured, as cattle running in pasture fields tread out more or less grass and stomp the ground, which is bad for it.

RECLAIMING LAND

The Government is spending large amounts of money for irrigation. If the State of Iowa would pass a drainage law, the same as Illinois has, issue 4 per cent bonds which they could sell, and loan the money to the farmers to drain the Missouri bottom by making proper canals and outlets for the rivers, they would make more good acres of land than the Government will by spending millions of dollars for irrigation.

With proper outlets for the water, the farmers in the Missouri bottom would soon pay back to the State all they had borrowed to carry out this system, for then they would possess some of the finest lands in the world. Necessarily, the farmers must begin to think, and send men to the legislature in their interest and in the State's best interest. Wouldn't it be better to let the farmers have their own drainage districts and do the work themselves, as they would probably do the same work at one-half the cost the State would do it for?

THE FARMER IS KING

People generally think that farming is a laborious occupation, but by the ingenuity of our machinery manufacturers, the burden of farming has been reduced so that very little laborious work is done on a farm. In fact, it is the most independent life a man can lead; and, with rural free delivery, and by taking a good newspaper, the farmer can know what is going on in the world. Life on a farm gives children a good constitution, and, with our free schools, their opportunities are better than those of the

boy raised in the city. So far as living is concerned, the farmer is 100 per cent better off than half the people living in cities. I took a friend of mine down on a farm once, and he remarked that he supposed he would not get much to eat. I said, as he was raised in Vermont he would probably get along with a rind of pork, and bread and milk. He replied he could get along if he got plenty of good bread and milk. We drove up to a farm house and I told the lady we would like some dinner. She said it would be ready in two hours. After my friend ate his dinner he commenced writing, and I asked him what it was about. He said he was making note of the fact that although he had eaten at Delmonico's and Kinsley's, and a good many other places, this was the finest dinner he had ever eaten. There were thirty-seven different dishes on the table, and all raised on the farm, except the coffee, sugar, salt, and spices. A good garden every farmer ought to have. If he would have a long garden, so he could cultivate it with a horse, and plant his vegetables in

rows, he would always have the finest vegetables in the world, while those in the city are, in a measure, stale.

CANTALOUPES

Cantaloupes are a delicious fruit. Plant them in this way: Dig a small hole and put in some horse manure; mix in some cow manure, and put some dirt over it. Take a half-inch board and make an open frame six feet long and three feet wide; take some cheese cloth and put it on the top to keep the bugs off. After the plants get well started, take the frames off, and if you have some fine animal fertilizer, sprinkle it over the vines. This will help them and also keep off the bugs. The Emerald Gem and Rockyford are good; Hackensack and Osage are better. They grow to weigh 12 to 15 pounds and are fine. To get them started early, cut a rich sod one foot square and put it in a small box and plant your seeds. If you have a cold frame put it in this; if not, set your box in the garret. They will start to grow and when the weather gets warm set them out and this will give you

early cantaloupes. I think any man will work better who has a cantaloupe for breakfast. All men appreciate good food and will respond when they realize their employers mean to treat them well. Every one likes to be considered. It costs a farmer but little to have a good garden, and it will pay him ten-fold in many ways.

DAIRY COWS

There is no doubt but what a farmer with 160 to 240 acres of land in Northern Illinois ought to keep cows, as that is the best stock, if he is within a reasonable distance of the market for his milk; for with the system I have laid out, he would keep his land in a state of high cultivation with the cows. I am informed that cows kept in a barn and soiled in summer will give more milk than those running in pasture. The farmer should have some phosphate on hand to mix with his manure, as it is necessary to have some kind of acid to liberate the phosphate from the Tennessee Rock.

STEERS

A farmer with 160 acres of land, living a good distance from the market, could keep forty steers if he soiled them in the summer. A farmer keeping steers would need a barn forty-two feet wide and sixty feet long, with racks on each side of the barn to feed his cut corn, clover hay, or oat straw, with a water trough on each side and a yard on the outside. This would give the steers a chance to walk in the sun, which is of great importance in fattening them. With a 12-foot loft over his cattle shed, he could use this space to store his corn fodder in.

In the summer let him mow his green clover and soil his cattle. On his corn fodder cut up, a little clover hay, and five ears of corn each day, his cattle would grow all winter. During the months of May and June feed them a peck of corn each day; then he would have a lot of fat cattle, and not feed over forty bushels of corn to a steer. If his farm is rich Illinois land, he would probably raise eighty acres of corn, forty acres of clover, and forty acres of rye,

and, with the manure and a little commercial fertilizer, would keep his land up in good shape.

80 acres of corn at 75 bushels per acre would be	6,000 bu.
To feed cattle, horses, and hogs would take	3,600 bu.
Leaving to sell	2,400 bu.
2,400 bu. corn at $.40 per bushel would be	$ 960
40 steers should bring a profit of	1,600
100 hogs should bring	1,200
30 acres of clover seed should produce	270
30 acres of rye should produce	360
	$4,390

Expenses:		
Two men	$720	
General expenses	200	
Grocery bill	200	
Interest on money invested in cattle	96	$1,216
Leaving a net profit of		$3,174

As a general rule, I think a small farmer better keep a good flock of ewes or cows than to handle steers; but if he has a fancy for steers and knows how to buy and care for them, he can make money with them.

DRY FARMING

To raise a crop of corn the land should be well cultivated before planting; it can't be made too fine and in too good a condition before planting. If the ground is properly prepared, a crop of corn can be raised much easier, and if kept mellow, a crop of corn can be raised without much rain. If the land is well pulverized before planting, and the corn planted in a furrow 2½ inches deep, it can be harrowed after it has been planted four or five days. This starts the weeds, and it can be harrowed the second time. This kills the weeds and keeps the land mellow, which should be plowed not less than four times. I think we all plant our corn too thick when planted in hills. Corn will not grow under a tree in a field; it must have the sun. If planted 4½ feet apart in

rows, in drills, one spear every nine inches, the sun reaches the blossoms of the corn. In this way we get 12,848 spears on an acre, while if planted in hills we get only 10,602 spears. A spear of corn growing alongside of another is an enemy to it when planted in hills. You seldom get over three ears, generally two, to each hill, but when the spears are grown separately, you will have an ear on every stalk and better ears. The farmer will say it is more work to cultivate the corn in drills than when planted in hills, but plant less acres and keep more in grass and raise more corn on half the land. If the corn is planted in a furrow 2½ inches deep and the harrow used at least twice after plowing, a crop can be raised as easily as if planted in hills.

You have probably read about dry farming in Colorado and Western Kansas. The farmers plow their land as deep as possible, and keep the top of the soil mellow so as to retain the moisture, and in this way they raise a crop with very little rain.

$100-ACRE LAND

It is a common remark: "I can't afford to keep live stock on $100-acre land," but this is a great mistake. The farmer who keeps his land in corn will wear out the soil in a few years so he can raise only half a crop, and the land will grow poorer every year. I worked one of my farms on the four-field system. I had 2,000 acres of corn which only shelled out 62 bushels per acre. One piece had been in grass for three years, and that shelled out ninety bushels per acre; so I am about convinced that I will have to adopt a new system—have five fields instead of four. Illinois as a State in a few years would raise more corn if it only raised half the acres, and kept part of the land in grass. This I have no doubt of.

BEAUTIFY THE FARM

I have always felt that if the Illinois farmers would take down their fences, set fruit trees on the outside lines of their farms, have only as many fruit trees as they can care for and spray properly, have a barn to care for their cattle, the same as

they do in Germany, and soil them, in the spring, Illinois would be a picture beyond description, and the barns would not cost as much as the fences.

TREES

Every man should set out trees every year. There is always some spot, not available for crops, on which trees can be grown. A catalpa tree will grow a trunk suitable to make a fine post in eight years, a railroad tie in fifteen years. Such timber will be of great value to future generations. The hard maple is one of the prettiest trees grown in our country, but a slow grower. Trees that are early to bud in the spring, such as peach trees, should be mulched after the ground has frozen in the fall so as to hold the frost in the ground until spring weather is settled; then take the mulch off and good peaches can be raised in most any climate. Trees beautify the country and we all love to see them. Let everybody, then, plant them.

THE GOOD FARMER

Sam Jones, the great evangelist, used to say he could always tell a good farmer. If he saw him leaning on the south side of the barn in March waiting for the sun to get strong, he was sure that man would never raise a crop. A farmer should always be ahead of his work. He must get out early in the spring to get his crops in; his oats should be sown as soon as possible; then he can plow his corn, for the more he plows his corn, if done intelligently, the more corn he will raise. But if he is behind in his work, the corn will be neglected. It is very important to keep the ground mellow if the weather is dry, for then it will stand a drought. If left hard, the sun cracks it, and it will not hold the moisture; but if kept mellow and in fine condition, it will stand a drought better, and a crop of corn can be raised if well tended and kept in proper shape. Don't plow too deep the last time for fear of cutting off the roots. Every farmer should try to plow his land very deep every four years, so as to make a deep soil. In traveling through Italy,

where they have very small farms and not much of anything to fertilize their land, I observed that they spade the land two feet deep, and thus make a deep soil.

TILED LAND

A hill of corn growing on top of tile will always be the biggest hill. Central Illinois is fairly well tiled, but still could be improved with more. When I was a boy an Englishman bought a farm in Ontario County, New York, on the banks of Lake Geneva, which was considered a high, dry farm. He hauled tile all winter to tile his land. The people said he was crazy, that his land did not need tiling; but he tiled it, ridges and all. In those days we were troubled with the weevil getting into the heads of wheat, but the Englishman's wheat was always ripe before the others, and he raised a fine crop. His farm gained such a reputation that he sold it for a nursery at a very high price.

In riding from Lake Geneva, Wis., to Chicago, I find that one-fourth of the land is wet and unproductive, and not of much

value. If the farmers would get together, hire a surveyor, find the proper outlet and make an open drain, they could then tile their land to it. It makes me sick to see their cows knee deep in the mud, eating bog grass—no nourishment. If some of the young men who have been raised on farms and educated in our free schools would take up this matter and get surveyors to find the natural outlets, they would add much to the value of their farms. The drainage law in Illinois is good, and I hope Wisconsin has as good a one. If not, the Legislature of Wisconsin should pass equally as good a drainage law. Experience teaches me that farmers cannot tile too much. To me it is a real pleasure to take a bad piece of land and make it into a garden.

SHEEP

For a small farmer I think sheep are the best stock, if he keeps the right kind and knows how to care for them. Good market lambs are in great demand and will always bring from 6 to 8 cents per pound, and a farmer should get $600 to $700 net on 100

ewes. Sheep are better than cattle to keep the land in a state of high cultivation, as they keep the land free from weeds. Take any of our good Illinois land and divide it into four fields; raise 80 acres of corn, 40 acres of clover, and 40 acres of rye, sowing the rye after the corn is cut up. Probably a farm of 100 to 160 acres would not keep more than 80 good ewes, but, by having a little fertilizer, having one-fourth of the land always in clover, I think the land could be kept up, as he would have the manure. I think a man working a farm on this system necessarily would have to buy a little commercial fertilizer—some phosphate rock or bone meal.

WEEDS

When you sow clover with your oats, rye, or wheat, if the land is rich and you get any rain in August, the weeds will start. They should be mowed the first of September, when green, before they go to seed. They will rot quickly and make some fertilizer. The clover will have a chance to grow in September and October and make a good root, and will make a much better

crop the next year. The bigger the clover, the bigger the next crop of corn will be.

EARLY POTATOES

To raise early potatoes, plow the ground in the fall. Then plow out a trench early in the spring and fill the trench with good horse manure; tread it down well, and put a little dirt on the manure; plant the potatoes, this and will give you early potatoes. You can plant this same ground in late potatoes, which are better for the winter. You can start early lettuce and radishes in a trench of this kind, and in this way get them two weeks earlier than by planting on top of the ground, as is usually done.

GIVE THE CHILDREN AN INTEREST

Many farmers think they cannot afford to give their children anything, but this is a great mistake. Give them something to be their own. You must do this if you want right-thinking boys and girls, and you will have more willing hands to help you get out of debt. I knew a farmer living in Ohio who gave his daughter the privilege of raising

chickens. She made more money in this way than he made on his farm, and her work resulted in his turning his farm into a chicken farm. So you see he gained by giving his daughter something of her own.

Give a boy an acre of corn as his own and he will commence to think, read, and study how to raise the greatest number of bushels. He will find that two spears of corn growing together are natural enemies. Let him plant his corn in a furrow with the spears twelve to fifteen inches apart; cultivate it on a flat surface and at least six times. In that way it can be kept clean. If planted in drills and in a furrow the dirt will naturally work all around the corn. He will see his father planting on top of the ground, in hills, with three to five spears, as a rule never getting more than three ears on a hill, generally two. The father will be putting the plow in deep the latter part of June, cutting the roots of the corn, hilling his corn to destroy the weeds, and the wind drying out the hills. He will hear his father complain of dry weather in July and August—corn firing. His father will say

to his neighbor, "It is getting very dry, but my son has an acre of corn that does not fire, and it looks as if he would raise two bushels of corn to my one."

The neighbor will say, "I don't see how you keep your children at home; my boys seem to dislike a farm, and want to go on the railroad." This neighbor, it seems, gave his son a colt, but after it grew up the old man sold it, and put the money in his own pocket. Consequently, the son naturally thinks the farm a poor place to live.

When I was a boy and lived on a farm, I was considered the best boy to work in Yates County, New York. I had a small interest, and this gave me courage to work for something of my own. With self-denial I saved $3,200 and established a character and credit so I could borrow $5,000 on my name. My credit was worth as much to me as the $3,200 I had worked twelve years to save. No boy can succeed unless he can build up a character and credit. I have young men on my farm who started to work for me by the month and now own 160 acres of good land.

CLAY LAND

A farmer having clay soil should plant corn only on sod. If the land is good wheat land, plant the corn 4½ feet apart, a spear for every nine inches, and then cultivate the wheat in the corn. This is one of the cheapest ways of raising wheat. You have summer fallowed your land all summer by plowing corn. In the spring sow the clover seed, and as soon as the land is dry enough so the horses will not sink into the ground, drag the wheat and roll it. This will help the wheat, as it loosens the crust formed in the winter. You will have a fine stand of clover, which will be knee high in the fall. Pasture it one summer, or cut and soil it, and put what manure you have back on the land. The next year it will be ready for another corn crop, but if the land is weak and not rich soil, it should be pastured two years. If the land is good wheat land and fairly good corn land, it should be divided into four fields, so as to have one-fourth in corn and one-fourth in wheat. If good land, it could be worked on the three-field system—corn, wheat, and clover—and keep the land up.

I once knew a lawyer who lived in Ontario County in the State of New York, who had a hard clay farm—good wheat land. He kept one-half in wheat, dragged his wheat every spring, sowed his clover seed, rolled it, and pastured his clover the next summer; mowed part of it for hay, and kept a flock of sheep. His clover generally grew up in his wheat stubble in the fall, and he broke his clover sod and sowed it to wheat. In that way he kept one-half his land in wheat and one-half in clover. He always raised the best wheat in the country, and he was a lawyer at that, and they are generally poor farmers. Of course, a farmer cultivating a wheat farm in this way should keep sheep.

SYSTEM

Generally, farmers have no system. They fail to lay out their land into lots so they can adopt a system of rotation. It is of great importance to know each year where to sow and plant corn, oats, or rye. It is very important to get a good set of clover. Northern Illinois raises corn and oats, but if the land is rich, the oats will fall

down—and it is a gamble whether you get a good set of clover or not. We find by cultivating clover in, the same as we do oats, we get a better stand, as it gets a bigger root and lives through the hot weather, after the oat crop is harvested. But to be sure of a stand a farmer should raise one-half rye. If the rye is dragged in the spring, and the crust broken, the clover is sure to get a good stand. With clover I should always sow two quarts of timothy. Orchard grass is better, if you can get the seed. A good many of our agricultural societies recommend what they call a catch crop, such as soy beans and other crops of that kind, to be sown in with your corn. But if you raise a crop of corn worthy of a good farmer, a catch crop will not amount to anything, for it will not grow in with big corn.

THE HOG THE MORTGAGE PAYER

I have always found the hog to be the money maker on a farm; but we all fear the cholera. My convictions are that cholera is produced by over-feeding of corn.

Farmers should raise some barley to be ground, for a change of feed. To raise hogs with a profit you should have your sows pig in February. Take 16-foot boards and saw them in two; make a coop fastened up tight on both ends, and have a door for the sow to go through. Put straw around it, or bank it up with dirt, so as to keep it warm. Have some warm slop for the sows when they pig, so as to make milk for the pigs. When young, keep them growing with slop of barley, oats, or rye, or some other grains, and, of course, in the spring it will be well to make a temporary fence and fence up a few acres of clover for them to run in. If fed a little grain while running in this clover, they would make that piece of clover land very rich. By having your pigs come in February, you are enabled to get them fat and sell them by December, and not be obliged to feed them through the winter. It costs money to winter pigs, although a little alfalfa, cured nicely, will be a great help in wintering your pigs or brood sows. They will eat it like a steer eats hay, and

you can winter a brood sow on alfalfa with very little corn.

During all the years that I personally lived on a farm, we never made any money unless we had some pigs to sell. In Illinois, they are called "mortgage payers," which I guess is the proper name for them. The farmer who has some small fields to sow to peas, some early and some late, to turn the hogs into during the month of June, would save his corn, and his hogs would make a great growth and make the land rich so it would raise a good crop of corn the next year. In dividing up these little fields he might have a temporary fence that could be removed.

When my son first commenced farming, he said, "I see one of your drawbacks is that you lose your hogs with the cholera. When I was in France, I found the farmers who raised chickens made little coops and scattered the chickens over the farm so as to keep but few together." He thought he would make some hog coops similar in shape but larger, and scatter them over the farm and in this way avoid the cholera. He did

this and has been very successful so far in raising hogs. He is now raising barley to grind and feed his hogs, for a change from too much corn.

COUNTRY LIFE THE BEST

People in the country think living in the city yields more pleasure than country life; but this is a mistake. Two-thirds of the people living in the city don't live half as well as those living in the country. Having lived on a farm for twelve years of my life, I know, and I am sure I had as much pleasure as the people in the city. Mothers in the country have confidence in their daughters and sons, and are not obliged to have chaperons. We enjoyed going to dances, parties, socials, and sleigh rides as well as the young people in the city. People think that the rich get more pleasure and happiness out of life than the people in moderate circumstances. This is another mistake. The rich are not the happy people of the world. I don't think the richest man in the world gets as much pleasure out of life as the young man who starts out to

establish a character and a credit, marries some noble young woman, builds a home he can afford, surrounds himself with true friends, and lives a manly life.

BOYS

I say to the farmers' boys: "You are needed in the city, for nearly all city boys degenerate in the third generation. But never go to the city until you have accomplished something at home. If you do, you will fail."

A boy raised on a farm, living in the country, in the springtime, sees Nature putting forth all her energies; the trees blooming and blossoming to bear fruit. He sees in this beautiful picture a lesson, and begins to realize that this is the springtime of his life. As time goes on, he must ripen to true manhood and bear fruit that will make a place for him in the world. So long as he obeys the laws of his country and his God, he is as good as a king. Do not think there is anyone better. Buckle on the armour and, with high ambitions, strive to be a man in the highest sense of true

manhood. In your spare time study the English language and you will be fitted to fill any position. Do not forget that in this life it requires pluck, energy, self-denial, with industry and economy to save something and build up a character and credit—that with these nothing can stop you from being a man among men—respected and honored by all. Associate with girls, as they have a quicker conception of right than boys, and will, as a rule, give you a higher idea of life. Avoid saloons. They are the great evil of our country. They fill our land with drunkards, destroy true manhood, and populate our land with children brought into the world by degenerate parents, and raised in crime, sorrow, and hunger. Many a poor woman is beaten and disgraced by a drunken husband, who in his earlier days was filled with love and devotion. Never associate with young men who patronize saloons, for if you do, no one can tell how low you may fall. How many promising young men have I seen who started out, as they called it, to be sociable and take a drink, scorning

the idea of being a drunkard, but in a few years were rolling in the ditch of degradation—a disgrace to themselves and their friends. Nearly all the great men of our country have achieved their success by their own exertions. It is well to read the histories of the lives of successful men, but don't forget that you must impress people with your individuality, thinking for yourself. In the winter join a debating class, for this will help you to express yourself.

In traveling abroad and seeing how they live in the old world, I can't help but feel that a child is blessed when born in Illinois, and the country is better than the city. Think of the children born in great cities, living on the sidewalks and brought up in sorrow, crime, and hunger. Chicago arrests 17,000 young boys yearly, who have been brought up in misery and never know when they will get a full meal. Are not children blessed who are brought up in the country?

GIRLS

A farmer's daughter should be loved by everyone, for she has it within her power to win everyone by making all who come to

her father's house at ease. Do not complain, but realize that occupation is happiness; make others happy and you will receive your share—be the sunshine of the house and never say a word against anyone. If you feel there are people you should not associate with, let them go. Better spend your time learning to cook. Many a man has lost his heart eating a good dinner. Do not be ashamed of your position in life, for you are a queen. A good woman is the great promoter of good, and men would be brutes without them. The farmer who does not love and appreciate his wife does not often succeed. Girls should try to get a good English education. If you do not have a natural gift for music do not spend your time trying to learn to play the piano. It is so much precious time wasted. Do not mourn your fate because you are not a rich man's daughter, for as a rule, they are the most unhappy girls in the world. The farmer's daughter is far better off than hundreds of daughters born in the city.

I once knew a farmer's daughter who was the oldest girl at home. She made it

pleasant for everyone who came to her father's home; she never complained, but realized that she had a duty to perform, and was anxious to do her part in the world. She looked after the younger children and made them happy, and thereby gained happiness for herself. I fell in love with her, and if the wealth of the world had been offered me to forego the farmer's daughter, I should still have taken the daughter. When young men call, do not be bashful, but make them feel at ease. A bright girl, though not so pretty, can always win a man her equal. Do not feel above the young men, who, although plain, are industrious and trying to build up a character and a credit. They are far above the men who have money and have no motive in life. Never marry if you are not sure you are loved, and that the young man has a good character. It is far better to be a single woman, for they are oft times the most important ones in the household.

There should be some recreation for those living on a farm. The father should supply his wife and daughters with a horse and

buggy so that they can go to town and associate with their neighbors.

KEEPING BOOKS

A farmer should always keep books to know just what he is doing. Take an inventory of everything on hand the first of January and put it on the left-hand page; under this charge all purchases of stock, material, wages, and other expenses during the year. On the right page credit all sales of stock, products, etc., made during the year. Then take an inventory of everything on hand Jan. 1st, following, and place this on the right-hand page, under the sales. Foot both right and left hand pages, and the difference between the two footings will be the profits for the year.

Start the next year's books with the inventory last taken, placed on the left-hand page, and follow same method of charging and crediting as before. The merchant who does not keep his accounts and sees what he is doing generally goes to the wall. It is such a simple thing for a farmer to know what he is doing. He has

but a few things to inventory. By keeping accurate accounts he will soon discover his mistakes, which is a very important thing to know. I never knew of but one man who did not sometimes make a mistake. That was a tramp who asked for some breakfast. I told him if he would split some wood he should have a good breakfast. He replied that would be the first mistake he ever made—to work.

KINDNESS

I learned when a boy that kindness promotes good, retaliation evil. When I was thirteen years old I used to drive sheep and lambs, cows and calves from Amenia to Poughkeepsie, thirty miles, which took two days. An old Quaker, by the name of Howland, had some fine cherry trees. I used to run up on his steps, break the small limbs, and steal his cherries. I was going home with a farmer by the name of Kline one day who had a boy of my age. We asked Mr. Kline if he thought Mr. Howland would give us some cherries. He said "yes," and he drove up to the house and said to Mr. Howland, "The boys would like

to get some cherries." He said to come and get all we wanted to eat, so we climbed up the trees and filled our ten-cent straw hats with cherries. When I came down Mr. Howland put his hand on top of my head and said, "Are you not the boy who drives sheep and runs in and breaks the limbs of my cherry trees?" I said "yes," and expected he would cuff or scold me, but instead he said, "My boy, when you come along again, come in and get all you want, but do not break off the limbs and steal the cherries." This was a lesson to me I have never forgotten. I realized that his kindness had won my respect and love. Had he kicked me I should always have felt a spirit of revenge. This changed my idea of life, and set me thinking. Was it not better to do right, and make friends rather than enemies? I set out miles of apple trees on the side of the road around my farm in remembrance of this grand old Quaker.

SEED

It is just as important to have a good seed corn as to have a good breed of cattle. To breed corn is very simple. Take twelve

good selected ears of corn; plant one row with the corn from one ear, and the next row with the corn from another ear. When the tassels form, pull off the tassels from every other row, so the row from which the tassels have been removed will have to breed from the next row, and in this way the corn does not inbreed. Do this for a few years, and you will have perfect corn for seed.

HOW TO SECURE SEED CORN

Pick your best ears when they are good roasting ears; leave the husks on and hang them up where they will dry; when planted, every kernel is sure to come up, and your corn will be earlier. This is an experiment I have tried, and know it is all right.

I think it is important to change your oats. I find by planting oats grown in Northern Wisconsin that we raise a better crop of oats in Central Illinois. It is always very important to have good seed of all kinds, and I think it a great benefit to change your seeds from the North to the South.

MANGEL-WURZELS

I think it always pays to raise mangel-wurzels and have a few beets to feed chickens in February. This will increase your egg crop. Mangel-wurzels are fine feed for young growing pigs in September, October, and November. They will eat them with a relish, with a little green corn. You can get a big growth very cheap if the ground is properly prepared, but if the land is weedy, better leave them for the other fellow to raise. A few roots are always good to give to all kinds of live stock in the winter. Carrots and beets are better, but cost too much to raise. Mangel-wurzels grow big and answer the purpose and are more easily raised.

OATS

Oats in Central Illinois should be sown as early as possible. If the ground can be prepared in the fall, it would be better to sow them in February, the same as you sow clover and timothy. The oat crop is said to be short this year, but oats that were sown early are, apparently, as fine a crop as ever grew. In Central Illinois, particularly, it

is very important to get your oats in early so they will mature before the sun gets too hot, and if you wish to seed after oats, if sown early you are more liable to get a good stand of timothy or clover.

HOW TO GET STARTED IN THE SPRING

The farmer should look over his plows and cultivators in January and see that they are all in good condition so when he starts in the spring he is not obliged to go to town and get his tools repaired. He should buy his groceries in February, and, if he raises rye or wheat, it is always well to sow his clover or timothy in February. He should always try to get his oats and corn in early. It is said that Illinois will raise only half a crop of oats this year, but the farmer who got his crops in the first of March appears to have an advantage. He should always try to plant part of his corn as early as possible, as that gives him a chance to cultivate his early and late corn. This is one of the drawbacks of most farmers—they never start early enough in the spring. The best crop of spring wheat

I ever saw grow in Nebraska was sown in February, and the man never got a chance to drag it in. If the ground is in condition it will always be well to sow your oats the last of February.

ORANGE COUNTY BUTTER

A farmer with 160 acres of land and wishing to get the most out of it, should keep 40 cows and make Orange County butter. If good Illinois land, he should divide it into four fields; he would need a barn 60 feet long and 42 feet wide; he should build a cement column and have two iron rods in this column, then bore two holes in his posts and set the posts on the cement column and this will hold them in place; then make a cement floor for a foundation and feed the cows from the sides of the barn.

He would probably have to have stanchions for his cows, but only to keep them in while being milked. Give them a chance to walk around and lie down in comfort. Have a yard on the outside where the cows can get water and get in the sun. Orange County butter is made in this way: Set the

milk in pans or tin pails; churn the milk and cream—one ought to have some power to do the churning; when the butter forms, put butter and all in a long trough, a foot wide, made of good oak, and have a stream of good well water running through it. Work the butter very carefully with your hands so as to wash out the buttermilk. If worked with a ladle it will make the butter salvy, but if made in this way, with the buttermilk taken out, and with a little salt, the butter will keep sweet a long time, and will always bring the highest price.

To keep your cows in the barn the year round, you would have to have 40 acres of clover fenced off. The cows would eat 15 acres of green clover, leaving 20 acres of clover for hay that should be made and put in small cocks; get some common sheeting soaked in oil and put on top of the cocks; let the hay set a day or two before putting it in the barn, and in this way you will have fine clover hay. You would have to sow five acres in peas in drills about three inches deep. Just before the peas come up sow one-half bushel of oats. Drag it in on top

of the peas. After you have fed your green clover this will make the best feed, cut green, for the cows; it makes the best hay for cows in the winter, and they will give more milk fed on green peas and oats than any other feed you can give them. You would have to raise five acres of sweet corn to feed after the peas are gone. To winter your cows you would have to cut your corn stalks; after they are cut up, put them in a tank and pour hot water over them; put a little bran on top to keep the heat in, and you will have some warm feed for your cows in the morning. You will have 70 acres for corn, 40 acres for clover, and 40 acres for rye.

40 cows, 300 lbs. of butter to one cow	$2,400
100 hogs to sell	1,200
70 acres of corn, sell 3,000 bushels	1,260
40 acres of rye, 1,200 bushels	600
	$5,460

You should raise a few calves from your cows to replenish the cows that are worn out. When you get your brand of butter established, you should get 30 cents per

pound for it, and ought to get 300 pounds of butter to a cow kept in this way.

WORKING PEOPLE

The laboring man living in the country would never be poor if willing to work and use a little economy. His opportunities are so much better than those of the people living in the city, for the laboring man in the city must buy everything, while the man in the country can own a cow, pigs, chickens, and have a garden, which is half of his living. Wages are higher in the city, but what have the city people? They are obliged to rent a house which costs five times as much as a house in the country, and everything they use must be bought at double the price, and stale at that. Their chances to save up any money are very slim. They don't work as many hours, but work much harder and faster when they do, and when out of a job, expenses go on. In the country a man is never out of work. The laboring man in the country is always respected by every one and not tempted to spend all he gets. A girl working for a

farmer's wife is always respected, which is far better than living in the city where people don't know their next neighbor.

WHEAT

The soil of the Mississippi Valley is spongy and the wheat is liable to freeze out when put in shallow; it should be drilled in deep. If the wheat is sowed shallow, the March winds dry it and blow the dirt from the roots and injure the wheat. Generally, we raise a good crop of wheat if we have a wet March. I know of a farmer in Nebraska who always raises a good crop of winter wheat, but he always drills it in as deeply as possible. He says it can be drilled in four inches deep and will come up all right, but the land should be well cultivated and pulverized, and in this condition, the wheat can be drilled in deep. A good way to raise wheat is to plant corn 4½ feet apart in drills, and drill wheat in the corn not later than the 15th of September.

HOW TO THRIVE ON FORTY ACRES OF LAND

Forty acres of good, well tiled land, with a comfortable house, a good horse barn for

three horses, a cow barn 30 by 30 feet, with a 15-foot loft to store corn fodder in, ten cows, ten brood sows, all other necessary stock, tools, etc., ought to be bought for $10,000. The cow barn should have a cement floor. Buy one carload of bone meal as a starter. Two acres for a house and barn and two acres for a garden leaves thirty-six acres to be divided into four plots. Raise sixteen acres of corn, planted in drills 4½ feet apart, and drop a kernel every nine inches. Have two acres in drilled corn to cut to feed the cows in August and September. Nine acres of the corn would have to be seeded with clover and timothy the last plowing, and fence off five acres of clover temporarily for a hog pasture. This would leave four acres to mow and soil cows on in the summer. Cows can be kept in a barn in the summer as well as winter with a small yard on the outside. Buy an old straw stack for bedding for the cows and about ten tons of phosphate rock to mix with the manure or put in the cow barn. With this you would make manure enough to cover ten acres

each year. The five acres of clover pasture with the hogs would be very rich. In this way you would manure one-third of the land every year. Sixteen acres should raise 1,600 bushels to feed the hogs, horses, and cows; seven acres in cabbage, two acres in mangel-wurzel beets, to feed to young hogs in September and October and have some for the hogs in the winter.

10 cows should produce		$ 600
50 hogs should produce		500
7 acres of cabbage		1,050
Chickens		200
		$2,350
Labor	$400	
20 tons phosphate rock	120	
Family expenses	830	1,350
Leaving a net profit of		$1,000

The farmer would not be as rich as Rockefeller and could not play golf. He would get his exercise in his corn fields and on his farm, but he would be a rich man compared with the average of mankind, and he would be independent. If he had

a good garden, he would live as well as any man. He would have to work, but occupation is happiness. It would be 320 rods around his 40 acres, but he would need no fences. He could plant 250 sour cherry trees, and if well sprayed and cared for, they should produce $400 in a few years. He ought to raise ten tons of cabbage on an acre, and it is always worth $15 per ton. If he knew how to make sour krout, he could get $300 per acre. The smart man might say, "Why not plant it all to cabbage?" But in that way he would soon raise very poor cabbage and have no manure to mix with his fertilizer and keep his land rich. He should have ten coops for his hogs and always have the pigs come in not later than the first of March and have plenty of soft coal on hand for them to eat.

SOFT COAL FOR HOGS

The object of feeding soft coal to hogs is to keep them in a healthy condition and free from worms. Hogs will eat common screenings if you put a little salt on them. The sulphur in the coal is what helps the

hogs. My son fed 105 tons of soft coal to his hogs last winter and they were always healthy. Soft coal is a cheap preventative of diseases.

He should feed the pigs a little slop so after three weeks they would learn to eat, and the hogs would be ready to sell in December. He might be a little short of hay for his horses, but if he is a hustler, he could get hay on shares from some of his neighbors. The sixteen acres of corn cut up with a corn cutter would winter his cows.

HOW TO GET A START

The young man says, "This is all right for the man who has his own farm, but what am I to do? I have nothing but my hands and good health." I will tell you. Hire out to some farmer, by the year, for $250 and board; save $200 of it and deposit it in a good bank until you can invest it safely. Keep on until you have $1,500 saved, and then rent a farm. You would then have a character and credit, and would have no trouble in renting a farm. With good health, nothing could prevent you from owning a farm. Get married when you have enough to start in life with.

HOW I GOT STARTED IN THE WORLD

In 1849, when I was 21 years old, I owned three horses, a lumber wagon, five cows, eighty sheep, and ten brood sows. I rented a farm comprising 120 acres, 20 acres in timber and 20 acres in stumps and stone, but very good pasture land, which left 80 acres of plow land. I took possession of this farm in February. The manure had not been hauled out of this farm for four or five years, so I hauled it out the last of February and first of March. I raised 40 acres of corn, 20 acres of barley, 10 acres of oats, and 10 acres of clover, and kept 80 sheep. I sowed my barley and oats the last of March and broke 20 acres of my sod for corn. We did not have very good tools in those days, but I cultivated this land well and furrowed it out with a one-horse cast iron plow, 3½ feet apart each way. I had an Irish boy working for me at $9 per month and hired a boy at 25 cents per day to drop the corn. I soaked the corn every night in warm water; took some tar and boiling water; coated the corn with a little tar rolled in plaster and

set it back on the stove to sprout; while the boys were planting one 20 acres, I broke the other 20 acres, and was all through planting before my neighbors got started.

40 acres corn, 50 bu. to the acre, 2,000 bu.		$1,300
20 acres barley, 40 bu. per acre, 800 bu. at 60 cents		480
Sold 40 stock hogs		240
Sold 15 steers at Christmas at $100 per head		1,500
Sold products of 80 sheep		240
		$3,760
Bought 15 steers at $60 apiece, got them home the first of Oct., fed them pumpkins, topped my corn, and fed them green corn through October	$900	
Fed them 400 bu. corn through November and December	260	
Rent	260	
One hired man for 9 mos., at $10 per mo	90	
Extra help	60	
Household expenses	150	
		1,720
Profit		$2,040

THE FARMER'S POLITICAL DUTIES

I have always believed that the success of this great Republic depends largely upon the intelligence of the American farmer, as great cities become more or less demoralized, and are always scheming to obtain something for nothing, advocating socialism, and Municipal and Government Ownership, which would concentrate the powers of the Government. The party in power would always remain in power; the people would lose the benefit of the elective franchise, and thus destroy the principles this Government was founded on, viz.: Individual rights with reciprocal duties. In fact, we would soon be a Government as arbitrary as the Russian Government. The man in power would wield so great an influence that he could not be removed. With Municipal Ownership of street railroads, waterworks, and gas plants the employees would all have to be politicians. They would control a power greater than money. They, of course, all have friends, and when we have an election they would say, "If we don't elect the party in power we will

lose our jobs," and in this way they would control every election. The same with Government Ownership. An ambitious President of the United States would have the power to renominate himself. As it is to-day, he may not be elected; but give him control of all the railroads and he would elect himself.

We better stand by the principles our forefathers laid down: "Give every man a chance to do something," to build up some industry, something that would benefit mankind, instead of making every man subject to the dictation of someone in power. I fully realize the danger of concentrating the powers of this great free country into a few men's hands, and I believe every man who loves the principles of our country has a duty to do in trying to prevent this. Abraham Lincoln said our Government is "a Government of the people, by the people, and for the people." If we had Government Ownership and Municipal Ownership, the party in power would remain in power. Would it then be a Government of the people, by the people,

and for the people? Would it not become an arbitrary Government controlled by a few who are in power? I think it is wise to shun political parties who advocate Government Ownership and Municipal control, if we wish to have a free Government controlled by the people.

I think the farmers should take a great interest in politics. The politician who tries to divide our people into classes by appealing to prejudices and jealousies is a dangerous man. I have heard men say that a national debt is a national blessing. But a nation in debt is not different from a farmer in debt, for the debt must be paid. In the old world at least one-half the people's earnings or income must go to the Government; consequently, it is hard for a young man to get started in life in his own country. The bright ones generally come to our country. We now have politicians clamoring for Government Ownership and Government control. What will the result be? A great national debt will be piled up. As an illustration, think what it costs the Government to do any public work. The

Government has been fifteen years digging the Hennepin Canal, which is only ninety miles long and sixty feet wide—and no boat can draw over four feet—and is costing millions of dollars.

The farmers of Henry County are digging a ditch 22 miles long, 100 feet wide, and 11 feet deep for $400,000. They could have dug the Hennepin Canal in two years for one-fourth the amount it will cost the Government to do the work. Politicians are circulating a petition to get Congress to appropriate money to build a ship canal down the Illinois River, which would fill up with sand every spring and be another Hennepin Canal, and practically of no use to anyone.

Canals are obsolete. Every intelligent man knows that a double-track electric freight railroad, to run at the rate of twenty miles per hour, would haul the products from Chicago to New Orleans for less than it would cost to tow a barge up the river against the current. A double-track electric road would not cost one-tenth as much as a ship canal, and this would be business

—not sentiment. When they had the ship canal completed, costing untold millions, with its locks and water-power, people would want bread. The locks would prohibit the reclaiming of millions of acres of the richest land in the world. These locks would have to come out.

A great national debt means taxation. Government Ownership and Government control means that the individual energy of the nation will be broken. We would be retrograding—would be a nation of taxpayers controlled by Government officials, and our individual independence would be destroyed.

The great men of our nation have been running our Government on sentiment for the last ten years. Out of sentiment we commenced war with Spain to defend Cuba. We spent millions and sacrificed the lives of our soldiers, and, through sentiment, said to Cuba, "You may have your independence." An English statesman would have said, "You may get under the old flag and be one of us, but if you wish to be an independent nation, you must give us

bonds for what we have spent in defending you." We should possess Cuba for a national defense, but can we afford to spend millions to protect it when it is of no use to us during a war? We bought the Philippine Islands, and are now spending $50,000,000 to educate its people, some of whom have twenty wives, which means a good many children for us to educate. We did not need the Philippine Islands—far better for us to take care of our own people. In our large cities no less than 100,000 boys (brought into the world by degenerate parents, and raised in crime, sorrow, and hunger) are arrested yearly—and we send them to reformatory prisons to be pushed on downward. Is it any wonder that our land is filled with criminals?

We are spending millions to build the Panama Canal. It will probably take forty years to build it, and it will cost one thousand millions of dollars. This is being done by public sentiment—not good judgment. We could build good docks on each side, with proper facilities for loading, unloading, and transporting the products across the

isthmus, for one-tenth of what it will cost with a lock canal.

We may stand it now that we are young and rich, but future generations will have to pay the debt. If we continue to run the nation on sentiment, we will burden ourselves with such a national debt that a farmer will not be able to buy a plow without having the Government stamp on it, and we will have a nation filled with Government officials to collect taxes.

SELECT YOUR REPRESENTATIVES CAREFULLY

Every man who loves the success of this great Republic—a land of equal rights to all—must see that professional politicians are not the right men to administer the affairs of this nation. The judges who have served the people faithfully for fifteen to twenty years are the ones who should be honored by being sent to the Senate and the House of Representatives.

CORN BREAD

One cup and a half of white cornmeal; a pinch of salt, and butter the size of a large walnut; pour on boiling water, and stir until you have a thick batter; then drop in the yolks of three eggs and the beaten whites; add a teaspoonful of baking powder. Bake three-quarters of an hour.

ILLINOIS SOILS IN RELATION TO SYSTEMS OF PERMANENT AGRICULTURE

BY CYRIL G. HOPKINS

UNIVERSITY OF ILLINOIS

Agricultural Experiment Station

URBANA, FEBRUARY, 1907

CIRCULAR NO. 108

ILLINOIS SOILS IN RELATION TO SYSTEMS OF PERMANENT AGRICULTURE *

BY CYRIL G. HOPKINS

To permanently maintain profitable systems of agriculture is our most important material problem, not only in Illinois, but in the United States of America. It is necessary that agriculture as an industry shall be self-supporting, and agriculture must in large measure support our other important industries. Every form of agriculture rests primarily upon the fertility of the soil, whether it be grain farming, fruit growing, dairying, or live-stock husbandry.

Some small countries can derive their support largely by conducting commerce and manufacture for other countries, being enabled from the profits of their enterprise to purchase food and other

* An address read before the Illinois State Farmers' Institute at Quincy, February 20, 1907.

necessities from their colonies or from other agricultural countries; and some forms of intensive agriculture, as market gardening, can be supported in restricted areas by the waste fertilizing materials from nearby cities, but we may well remind ourselves that the American Nation and the general agriculture of America must be self-supporting; for we can never hope to draw upon our colonies, nor upon other countries for our support.

If we succeed in Illinois in discovering, and in demonstrating, and in practicing, permanent systems of profitable agriculture, this State will be the first example in the history of the world to adopt agricultural methods that will maintain the fertility of the soil without the purchase of food and fertilizer from foreign countries.

Rapid Land Ruin

Among all the nations of the earth the United States stands first in rapidity of soil exhaustion. The improvement of seed, the use of tile drainage, the invention and immediate adoption of labor-saving agricultural machinery, the wonderful development of cheap and rapid means of transportation, and the opening of the world's markets to the American farmer, have all combined to make possible and to encourage the rapid depletion of American soils, until agricultural ruin already exists, practically, over vast areas in the older parts of this new country, the United States of America, while it is common knowledge that even

in this new rich State of Illinois the lands that have been under cultivation for half or three-quarters of a century are much less productive now than they once were.

In our prosperity and abundance we almost forget the present famine in Russia;* can scarcely realize that much of the time more people are hungry in India than live in the United States; and will not remember to-morrow the call of to-day from President Roosevelt and from our state governors for help to relieve the widespread famine and actual starvation now existing in China. Meanwhile, shall we go on, as a people, ignorantly, carelessly, or wantonly robbing our soil of its fertility and American posterity and our children of a rightful heritage?

The almost universal practice of the civilized world to this date has been to ruin land, and then to seek out newer lands on which to repeat the proc-

* Kazan, Russia, Feb. 20—"The correspondent of the Associated Press has returned here after a twenty-five days' trip through Kazan, Samara, and Ufa, three sample provinces of the twenty affected by the famine. The correspondent investigated the situation in all directions, traveling 500 miles by sleigh in districts remote from railroads where the distress is most acute.

"The population everywhere was found absolutely dependent on outside relief. The present state of affairs is characterized by slow starvation and extreme misery. The government's allowance of 36 pounds of rye per person, per month, is most inadequate and this amount is cut by 18 or 20 pounds by the cost of transportation and milling. Men and even women between 18 and 55 are excluded from receiving the government ration. In the province of Ufa there is scarcely half the quantity of grain necessary for ordinary subsistence of the people, and peasants are in such weakened physical condition as the result of succession of bad harvests that supplementary assistance is necessary for thousands to make it possible for them to survive until spring and have strength enough to plant their new crop. The reports from other districts are practically the same, the burden of all being intense suffering and gloomy outlook for the future." (From a dispatch in the daily newspapers of February 20, 1907.)

ess even more quickly. There is extreme poverty among the people of the world almost wherever they are dependent for support upon the agricultural resources of ordinary land that has been under cultivation for two centuries.

I repeat that, if it is possible, and if we shall succeed in Illinois in discovering and adopting into general agricultural practice systems of farming that will restore our soils to their virgin fertility and permanently maintain a high productive capacity for these Illinois lands, it will be the first time for this to be accomplished anywhere in the world over such an area.

If we are ever to adopt systems of soil improvement it must be done while we are prosperous. People living in poverty on impoverished lands have no money to invest in the improvement of their farms, no matter how great returns such investments would promise in future years. Soils that have been running down for a century cannot be built up economically in a year, so as to pay an immediate profit on the improvements.

While many Illinois farmers are already beginning to adopt methods of permanent soil improvement, by far the most common practice in the State, if continued, must inevitably result in land ruin. The only kind of soil treatment in common use that is even believed to benefit the soil is crop rotation, including an occasional clover crop. It is a fact, however, that crop rotation is a means of

depleting the fertility of the soil, and clover used in this way in grain farming serves only as a most powerful soil stimulant, leaving the soil poorer with every passing rotation until crop yields become reduced, clover being the first crop to fail in this system. It is at this point in the process of soil depletion that land values usually begin to decrease, and as a rule this decrease is rapid. Under the successful clover system of grain farming the landowner may receive one-half of a sixty-bushel crop of corn, which at 35 cents a bushel will provide 50 cents an acre for taxes and still leave $10 an acre, which is sufficient to pay five per cent interest on $200 land. But ten or twenty years after the clover system fails, the landowner may be receiving only one-third of thirty bushels of corn per acre, which with the same price and taxes would leave him only $3.00 an acre, or sufficient to pay five per cent interest on $60 land.

There are now on file in my office at the University about ten thousand letters relating to soils, written by Illinois farmers and landowners during the past six years. From this mass of correspondence alone, I feel that I know the opinion of the most progressive and observing farmers in Illinois regarding the tendency of crop yields under present systems of farming. The following extract is taken from a letter received from Plainfield, Illinois, since the preceding paragraph was written:

"Will County is a rich agricultural part of Illinois, naturally; but fifty to sixty years of cropping, with

no systematic and scientific effort to keep up soil fertility, has resulted in a decrease in yield of crops from 25 to 35 per cent. If this continues another generation, it will be proportionately worse, and farms now held at $125 to $150 per acre will be held at $65 to $80, of necessity."

Plant Food in Rich Soils

Lands that are valuable produce large crops. Soils that produce large crops are rich soils. Rich soils contain a large store of plant food. If we are to maintain Illinois lands in a high state of productiveness and at a high value, we must maintain in our soils a large supply of every essential element of plant food.

It is worth while to remember that there are ten essential elements of plant food. If the supply of any one of these elements fails the crop will fail. These ten elements are carbon and oxygen, taken into the leaves of the plant from the air as carbon dioxid; hydrogen, a constituent of water, absorbed through the plant roots; nitrogen, taken from the soil by all plants and also secured from the air by legumes; potassium, phosphorus, magnesium, calcium, iron, and sulfur, all of which are secured only from the soil.

The soil nitrogen is contained in the organic matter, or humus, and to maintain the supply of nitrogen we should keep the soil well stored with organic matter, making liberal use of clover or other legumes which have power to secure nitrogen

from the inexhaustible supply in the air, the clover being plowed under either directly or as a farm manure.

It is interesting to know that an acre of soil seven inches deep, if it possessed the average composition of the earth's crust, would contain sufficient iron to meet the needs of one hundred bushels of corn every year for 240,000 years, sufficient calcium for 61,000 years, magnesium for 7,600 years, sulfur for 2,100 years, and potassium for 2,400 years, but sufficient phosphorus for only 120 years.

These numbers are based upon the average composition of the earth's crust, as estimated by Professor F. W. Clarke of the United States Geological Survey. They are certainly significant to the student of soil fertility, although perhaps no soil possesses exactly the average composition of the entire crust of the earth.

It is also of interest to know that the nitrogen resting on an acre of the earth's surface is sufficient for 100 bushels of corn every year for 700,000 years, although the nitrogen contained in the plowed soil of an acre is rarely sufficient for more than fifty such crops.

Only two essential elements of plant food are becoming deficient in ordinary Illinois soils. These are nitrogen and phosphorus, neither of which is contained in the plowed soil of our commonest lands in larger quantity than would be required for maximum crops during the full time of one life.

There are some soils whose fertility can be maintained at low-yielding power by crop rotation alone. This is on sloping land whose surface soil is washed away at least as rapidly as the fertility is removed by crops and whose subsoil is as rich or richer than the surface in mineral plant food.

I have found some places where soils of this topography, with subsoils rich in mineral plant food, have been cropped for centuries with the production of two or three grain crops every ten or twelve years, the intervening years providing for the accumulation of nitrogen by legumes while the land is kept in pasture. These lands are valued at about $10 to $20 an acre and so far as I can see this value can be maintained indefinitely without the application of farm manures or other plant food materials.

But I cannot comprehend how it is possible to maintain the common Illinois prairie and level upland timber soils at their present value and productive power if we continue to remove from these lands larger amounts of phosphorus and nitrogen than are returned.

During the past year I have had some very interesting correspondence with Doctor W. E. Macklin of Nankin, China, who has spent many years of his life as a student of Chinese and Japanese conditions.

On September 1, 1906, I wrote Doctor Macklin as follows:

"It would also be of much interest and value to me to learn the conditions on approximately level upland plains—lands which are not subject to erosion by surface washing and which do not receive deposits of soil material washed from higher lands. If there are such lands in China, it seems to me that if they have been cultivated for thousands of years and the crops largely removed they must have become exceedingly unproductive."

On October 6, 1906, Doctor Macklin replied as follows:

"I think you have struck the problem of China—how to make the table and upland soils productive .....I know a place ten miles in diameter of such land as you mention where no one lives..... There is lots of such land in China and even in North Japan where I have traveled."

This letter from China only confirms a common observation in all old agricultural regions so far as I have seen them; namely, that without the return of plant food in some form the level uplands must ultimately become practically worthless and barren, while the sloping hill lands maintain a very low grade of permanent agriculture.

It is certainly good farm practice, and usually the best farm practice, to remove the largest possible quantities of plant food from the soil, for the simple reason that large crops require large quantities of plant food; but it is no less important to restore to the soil, when needed, even larger quantities of plant food than are removed—by turning under legume catch crops and crop residues not removed from the field, by returning manures produced on

the farm, and so far as necessary by the purchase of commercial plant food, such as phosphorus in bone meal or rock phosphate, or, if needed, potassium in concentrated potassium salts.

Effect of Crop Rotation

Let us consider in further detail the effect of crop rotation on soil fertility. Suppose we are practicing a four-year rotation, including corn for two years, oats with clover seeding the third year, and clover for hay and seed crops the fourth year. Let us assume such crop yields as have been produced and as can be produced, in normal seasons on the richest, best treated land, with good seed and good farming; namely, 100 bushels of corn per acre, 100 bushels of oats, and four tons per acre of clover, including perhaps three tons in the hay crop and one ton in the seed crop. If we do not succeed in securing these yields we should at least try to make such yields possible and we should approach as near to them as we can. (On the best treated land at the University, 87 bushels of corn per acre have been produced as an average of the last five years, and on three different soil experiment fields in the State we have harvested more than 90 bushels of oats per acre.)

Let us first consider the phosphorus required for this rotation. The two crops of corn will each require 23 pounds, 17 for the grain and 6 for the stalks; the oat crop will require 15 pounds of phosphorus, about 11 for the grain and 4 for the straw;

and the 4-ton crop of clover will require 20 pounds of phosphorus. Thus we see that 81 pounds of the element phosphorus will be required for the rotation. If we leave the stalks on the land the requirement is reduced to 69 pounds of phosphorus, or to about 17 pounds a year per acre.

Suppose the soil contains in the first seven inches 1,200 pounds of phosphorus per acre, which is about the average of the principal type of soil in the Illinois corn belt; how many years would be required to remove this amount from the land if it could be drawn upon at this rate? Only seventy years. On the other hand, suppose with this crop rotation, we can secure from the soil the equivalent of only 1 per cent of the phosphorus contained in the first seven inches. This would be only twelve pounds of phosphorus a year, which would necessarily reduce the crop yields much below the amounts suggested above, and, with the further reduction in the total amount of phosphorus year by year, the crop yields must be reduced accordingly.

On the ordinary soils of Illinois ultimate failure is the only future for this system of farming, even if we consider the phosphorus alone; although, as stated above, the phosphorus may be returned in bone meal, in rock phosphate, or in sufficient amounts of farm manure.

If we consider the element nitrogen in this system of farming we find that 200 bushels of corn require about 200 pounds of nitrogen, aside from

that required for the stalks, and the stalks must be returned to the land without burning, otherwise the 96 pounds of nitrogen required for the two crops of stalks will also be removed from the land. The oats crop will remove 90 pounds of nitrogen, making 290 pounds per acre for the corn and the oats.

The four tons of clover will contain about 160 pounds of nitrogen and the clover roots and stubble about one-half as much as the tops, or 80 pounds per acre. If all of the nitrogen contained in the entire clover crop is taken from the air, the rotation would add only 80 pounds of nitrogen to the soil while the corn and oats would remove 290 pounds.

How then is it possible to maintain the supply of nitrogen by this rotation? It is not possible. Under such a rotation with all crops removed except the corn stalks, the supply of nitrogen grows less and less. Where this rotation is successful for a time it is due to the fact that the soil nitrogen has been drawn upon year by year while the chief effect of the clover has been to extract phosphorus from the soil for its own growth and for the use of succeeding crops.

There is another point to be considered in reference to nitrogen. On land that is capable of furnishing sufficient nitrogen for even a 50-bushel crop of corn, the clover crop will undoubtedly draw a third of its nitrogen from the soil and not more than two-thirds from the air. Consequently, since two-thirds of the nitrogen in the entire plant is removed

in the tops, the roots and stubble will leave no more nitrogen in the soil than the plant takes from the soil. How then can we maintain the supply of nitrogen in the soil? By plowing under sufficient clover or by applying sufficient farm manure, or better, by using both of these means.

If all the crops grown in the rotation are fed, including the corn stalks, containing a total of 526 pounds of nitrogen from four acres, and if three-fourths of this, or 395 pounds, are returned in the manure, we have sufficient to replace the 386 pounds removed in the corn and oats crops, and we may assume that the 160 pounds of nitrogen removed in the clover came from the air. Of course some additional nitrogen will be saved in the straw and stalks which are used directly for bedding and not for feed.

How shall the grain farmer maintain the nitrogen in his soil? Possibly this can be done by plowing under everything produced except the grains and the clover seed, preferably only one corn crop being grown in the rotation.

The problem of maintaining the nitrogen becomes easier if we extend the rotation to include about two years of pasture, using a mixture of red clover, alsike, timothy, and red top instead of seeding red clover only, with the oats. In this case three grain crops, as corn, oats, and wheat, or corn two years and oats one year, could be grown during the six-year rotation, the land being kept in meadow and pasture one-half of the time.

Use of Farm Manure

Farm manure always has been, and without doubt always will be, the principal material used in maintaining the fertility of the soil; but it is an unquestionable fact that the greatest source of loss to American agriculture to-day is in the enormous waste of farm manure.

If corn were worth $1.05 a bushel, then the average annual value of the corn crop of the United States for the past ten years, including 1906, would be equal to the average value of the total farm manure annually produced in this country. This statement is based upon the careful estimates of the United States Department of Agriculture, placing the average annual corn crop at nearly 2¼ billion bushels, and the average value of the manure annually produced by 20 million horses and mules, 61 million cattle, 47 million hogs, and 52 million sheep, at more than 2⅓ billion dollars.

The evidence is sufficient to fully justify the conclusion, and practical, observing farmers will agree, that at least one-third of the manure produced is wasted on the average American farm. If this is true, then the total value per annum of all commercial fertilizers used in the United States (amounting to about $75,000,000) is equal to only one-tenth of the annual waste of farm manure. This is no argument against the intelligent and profitable use of commercial plant food by those who make, and save, and use, farm manure to the

greatest possible practicable extent, but it serves only to emphasize the tremendous loss to the country from the waste that is permitted.

The opinion is sometimes expressed that the manure made from the crops grown on the farm should be sufficient to maintain the fertility of the soil. I have made diligent inquiry at many farmers' institutes in various parts of Illinois for men who own farms of 160 acres or more that have ever had manure applied over the entire farm made only from crops grown on the farm. I have found only one such man; and I believe that one-half of the land on 90 per cent of the farms of Illinois has never received a dressing of farm manure.

Value of Farm Manure

It is one thing to say that farm manure has a value, but quite another thing to say what that value is or to what it is due.

The positive or intrinsic value of farm manure lies in the amounts of valuable plant food which it contains. It also possesses an important indirect value as a soil stimulant, due to its power as it ferments and decays, in contact with the soil, to liberate from the soil plant food that would not otherwise become available so quickly. There is still another distinct value in farm manure due to the fact that it makes the soil more porous and spongy and thus increases the power of the soil to absorb and retain moisture and to resist surface washing. In other words, this third value of farm

manure is due to improvement in physical condition.

The value of farm manure for its physical improvement of the soil is commonly fully appreciated, and frequently overestimated, by popular agricultural writers, while its value for the plant food which it supplies and for that which it liberates from the soil is sometimes almost ignored.

There is no good excuse for erroneous teaching regarding these different values because there exists a vast amount of positive information both from practical experience and from exact scientific investigations.

Thus, organic matter from peat beds hauled out and spread on the land and incorporated with the soil produces no such effects on crop yields as are produced by good farm manure. Why? Because the peat does not decay readily so as to furnish plant food either by its own decomposition or by liberating it from the soil; and yet the peat has as great power as farm manure for physical improvement of the soil.

Manure made from clover hay and heavy grain rations has much greater value than manure made from wheat straw. Why? Is it because they affect the physical conditions of the soil in different ways? No. The great difference in value is due to the difference in plant food and in rapidity of decay.

At the famous Agricultural Experiment Station at Rothamsted, England, on a field to which no

manure and no plant food have been applied, the average yield of wheat has been 13.1 bushels per acre for more than half a century. Land treated with a heavy annual application of farm manure has produced 35.7 bushels of wheat per acre as an average of 51 years. Another field treated with commercial plant food without organic matter has produced 37.1 bushels of wheat per acre as an average during the same time. The latter field received a little less plant food than was furnished in the manure, thus furnishing ample proof of the value of plant food supplied in manure, and showing that the physical effect of the farm manure was by no means so important.

Nevertheless, the physical effect should not be overlooked. Under certain seasonal conditions this physical value may be very important. Thus, in the very dry season of 1893 at Rothamsted the land fertilized with commercial plant food produced only 21.7 bushels of wheat per acre, while the farm manure plot produced 34.2 bushels the same year.

In semi-arid regions the physical condition of the soil and its power to absorb and retain moisture may be the controlling factor in crop yields, but where the average annual rainfall is 28.21 inches (as at Rothamsted) or 37.39 inches (as in Illinois), with a fairly uniform distribution during the growing season, the physical conditions of the soil in relation to crop yields may be compared to the shelter and other physical surroundings provided

for live stock. In other words, under normal conditions the controlling factor is food, for crops as well as for live stock.

While manure has some value for physical improvement and a larger value of its power to liberate plant food from the soil, it should be clearly understood and always borne in mind that the great value of farm manure, especially in profitable systems of permanent agriculture, is due to the plant food it contains, and that the greatest problem in the handling of farm manure is to prevent the loss of plant food.

The value of average fresh farm manure is about $2.25 a ton either when determined by chemical analysis on the basis of present market values for the plant food contained in the manure or when determined by the value of the increased crop yields produced when the manure is applied to the fields in ordinary crop rotations.

This means that a pile of average fresh farm manure containing 100 tons is worth about $225. If exposed to leaching from heavy rains during only two or three months in the spring the value will be reduced as a rule from $225 to about $150 by the loss of plant food without much reduction in total weight. Indeed, the total weight is frequently increased under such conditions because the rainwater that remains in the manure may be in greater amount than the urine that has been washed out. Fermentation and additional leaching during the summer may easily reduce the value to $100 or less.

There are two satisfactory methods for handling manure:

One of these is to haul and spread the fresh manure daily, or at least two or three times a week. For this purpose a manure spreader, or at least a wagon used for this work only, is very useful and almost necessary.

The other method is to allow the manure to accumulate in the stall or covered feeding shed while it is constantly tramped by the animals and kept moist by the liquid excrement, sufficient bedding being used to absorb the excess and to keep the stock clean, and then to haul and spread it on the land when conditions permit. It should not be left, however, to dry out and heat and decompose in the stalls or sheds long after the animals have been turned out to pasture.

Selling Fertility

Every system of farming should be so planned as to be both profitable and permanent, which requires that the productive capacity of the land must be maintained. We must understand then what the soil contains, what materials are required to produce crops, in which parts of the crops these different materials are deposited, so as to know what part of the produce may be sold and what part should be retained on the farm; also what is done with these important plant food materials when the crops are fed to live stock.

The older prairie and upland timber soils of Illinois are exceedingly rich in potassium, but relatively deficient in both nitrogen and phosphorus. In the worn hill lands nitrogen is usually more deficient than phosphorus, while in the average long-cultivated prairie soil phosphorus is more deficient than nitrogen.

When grain crops are produced, as corn, oats, and wheat, about two-thirds of the nitrogen and three-fourths of the phosphorus but only one-fourth of the potassium required for the crop are stored in the grain or seed; while about one-third of the nitrogen, one-fourth of the phosphorus, and three-fourths of the potassium are stored in the straw or stalks.

Thus, a large crop of corn (100 bushels to the acre) will contain about 100 pounds of nitrogen in the grain and 48 pounds in the stalks; 17 pounds of phosphorous in the grain and 6 pounds in the stalks; 19 pounds of potassium in the grain and 52 pounds in the stalks. Quite similar relations exist between the grain and straw of other crops.

Now, with these facts in mind it is plain to see that a system of farming in which the grain is sold and only the stalks and straw are kept on the farm and returned to the soil carries off in the grain much of the nitrogen and phosphorus, in both of which these soils are more or less deficient and which should be returned to the land; while the potassium, of which the soil contains an inexhaus-

tible supply (enough in the first seven inches for 100 bushels of corn per acre every year for seventeen centuries), is largely returned in the straw and stalks.

It should be remembered that legume crops, as clover, cowpeas, and soy beans, are rich in both nitrogen and phosphorus, $3\frac{1}{2}$ tons of clover hay containing as much phosphorus, and 40 pounds more nitrogen, than 100 bushels of corn.

If the crops are fed to live stock, it is well to know that about one-fourth of the nitrogen and one-fourth of the phosphorus are retained in the flesh and bone of the animal, while three-fourths of the nitrogen and phosphorus and practically all of the potassium are returned in the solid and liquid manure.

Thus we have another process of separation by which part of the needed nitrogen and phosphorus leaves the farm with the animals, while the potassium is again returned, even though it may not be needed.

It should be a plain fact that manure made from animal excrements with straw or stalks for bedding must be deficient in nitrogen, and still more deficient in phosphorus, but rich in potassium, as compared with the requirements of the crop; and this is especially noteworthy when the manure is to be used on land already deficient in nitrogen and phosphorus, but well supplied with potassium.

In the case of nitrogen the difficulty can be over-

come by making a liberal use of clover or other legumes in the crop rotation and as catch crops, turning under these crops and crop residues so far as practicable. Legume crops may also be used in pastures to a considerable extent, thus securing nitrogen from the air to balance the deficiency in the manure.

With the phosphorus, the difficulty is greater, because the proportion contained in the manure is less, and there is no such ever-present inexhaustible supply as in the case of nitrogen.

Increasing the Value of Farm Manure

It must be apparent that to increase the value of farm manure we should add phosphorus to it. Thus we can balance manure and when used on soils rich in potassium in rotations with nitrogen-fixing legume crops we can provide plant food in a balanced ration to meet the needs of the maximum crop yields. By these means we can check the progress of soil exhaustion and even gradually increase the fertility and productive capacity of the land. Indeed, we can thus profitably enrich such land even beyond its virgin fertility.

By far the cheapest form of phosphorus is fine-ground raw rock phosphate. This material is but slightly available for the use of crops if applied to soils deficient in decaying organic matter; but, if applied in intimate connection with rotting

manure, it is thus made soluble and available for plant growth.

Certainly one of the most profitable, and probably the very most profitable, method of maintaining the necessary supply of phosphorus in the soil is to put back into the manure in the form of fine-ground raw rock phosphate somewhat larger amounts of phosphorus than the animal has retained in his bones. It is well for a time at least to put back larger amounts than the animals retain, because the soils are already deficient in phosphorus and also because there may be some waste of manure.

These statements are based both upon the chemical analysis of soils and crops and manures, and also upon carefully conducted field experiments covering many years.

The Maryland Experiment Station furnishes some valuable data from probably the earliest systematic investigations still being continued, and a large amount of information is rapidly accumulating from our more extensive work in Illinois; but the most complete experiments of long duration are reported by the Ohio Experiment Station. Where 40 pounds of fine-ground rock phosphate, costing about 16 cents, were added to each ton of manure and 8 tons of manure per acre were applied for a three-year rotation of corn, wheat, and clover, the value of the increase in crop yields was equal to $2.66 for each ton of manure

used, in case of yard manure (which was worth only $1.64 per ton without the phosphate); and, in case of the stall manure, its value was increased from $2.22 a ton to $3.42 by the addition of the 16 cents' worth of rock phosphate, these results being the average of nine years' experiments on three different series of plots, based upon increased yield valued at 35 cents a bushel for corn, 70 cents for wheat, and $6.00 a ton for clover hay.

If we deduct the cost of the phosphate used, we still have what might be termed a net value of $2.50 for the phosphated yard manure and $3.24 a ton for the phosphated stall manure.

Of course it would be equally appropriate, and possibly more so, to speak of "manured phosphate" instead of "phosphated manure," because the rock phosphate actually furnishes the needed and deficient element, phosphorus, while the manure helps to make it available. On this basis we may say that the value of 40 pounds of rock phosphate is increased from 16 cents to $1.02 by mixing with a ton of yard manure, and from 16 cents to $1.20 by mixing with a ton of stall manure, after deducting the value of the untreated manure in each case.

The most important fact to keep in mind, however, is that both the manure and rock phosphate are much more valuable when used together than when used separately, because manure is deficient in phosphorus and rock phosphate does not act except in connection with rotting organic matter.

As a rule it is better to use sufficient rock phosphate with each ton of manure so as to supply about 200 pounds of rock phosphate per acre for each year in the crop rotation. (A good grade of raw rock phosphate costing $8 to $10 a ton delivered in Illinois contains at least 12½ per cent of the actual element phosphorus. It is as rich as steamed bone meal, twice as rich as acid phosphate, and four times as rich in phosphorus as ordinary "complete" commercial fertilizers costing $20 a ton.)

There are two very satisfactory methods of mixing the rock phosphate with the manure. One is to sprinkle the phosphate over the manure from day to day as it is being made in the stall or covered shed. The other method is to fill the spreader part full of manure, then sprinkle phosphate over it sufficient for the load, finish loading with manure, and drive to the field and spread.

This produces an intimate mixture and a very uniform distribution, and requires practically no extra work to get the phosphate on the land. Care should be taken that the manure is not too dry when the phosphate is sprinkled over the load, otherwise the dry rock dust may get into the gearing or bearings of the spreader and cause them to wear rapidly.

Normal and Abnormal Soils

There are some extraordinary or abnormal soils. Thus, there are soils exceedingly rich in nitrogen and well supplied with phosphorus, but very defi-

cient in potassium; as, for example, certain peaty swamp soils on which the application of potassium produces an increase in the corn crop usually amounting to more than thirty bushels per acre, and on which Illinois farmers are already using about $20,000 worth of concentrated potassium salts annually, and with a net profit of more than 200 per cent.

There are soils exceedingly rich in phosphorus and well supplied with potassium, but deficient only in the element nitrogen, and which require only a liberal use of legume crops to be turned under as green manures or returned to the soil as stable manure in order to render them highly productive and profitable soils. Abnormal soils of this class exist in considerable areas in the geologic neighborhood of phosphate regions, as in certain sections of Tennessee and Southern Kentucky. Some of these soils contain twenty times as much phosphorus as the average Illinois corn belt soil.

But, when we consider the ordinary, normal upland timber and prairie soils of Illinois, there are two substances always to be kept in mind, and always to be provided in abundance, for any and every system of permanent agriculture to be practiced on these soils. These two essential substances are phosphorus and decaying organic matter, which will, of course, also supply the nitrogen.

It is not of so great consequence by what methods or in what forms these materials are supplied.

Phosphorus can be purchased in grain, or in other concentrated foodstuffs, to be fed with clover hay, it may be, and then applied in the form of farm manure; or phosphorus may be applied in the form of bone meal, which is also a farm product, or it may be obtained from the great phosphate mines of our southern states, as we obtain coal from our extensive mineral deposits.

The decaying organic matter may be supplied in farm manure, or in sufficient quantities of legume crops not harvested and removed from the land, but turned under as green manures, including the use of rotation pastures, or still better and more easily, and usually more profitably, by a combination of these methods.

But there can be no permanent agriculture for these soils by any system under which the phosphorus is removed and sold in grain and bone in larger amounts than are returned to the soil, nor under any system by which the organic matter of the soil is worn out or destroyed more rapidly than it is replaced.

On the other hand, systems of permanent agriculture for these soils are not only possible, but they are more profitable than any system under which the soil grows less productive.

Let us consider some of the results already obtained on soil experiments fields in different parts of Illinois on a few important types of soil.

Soils Deficient in Nitrogen

Normal soils on sloping hill lands are usually most deficient in the element nitrogen. They can be improved by growing clover or other legumes and turning these crops under either directly or in the form of manure. In some places, more especially in Southern Illinois, these soils are more or less acid, and this acidity must be corrected by lime or ground limestone in order to grow legume crops successfully.

On the Vienna soil experiment field in Johnson County, where corn is grown in a three-year rotation, 118 bushels of corn per acre have been produced as a total for the past four years on untreated rotated land. The turning under of legume crops and catch crops without lime has produced only six bushels total increase. Where lime has been applied with this legume treatment, the produce has been 168 bushels in four years, a gain of 50 bushels of corn, or 12½ bushels a year. No further increase in corn has been made as yet by phosphorus or potassium.

Four wheat crops on untreated rotated land (wheat being grown on the same land once in three years) have produced 12 bushels, averaging three bushels a year. Where legumes have been turned under the four crops of wheat amounted to 24 bushels, and with legume-lime treatment 47 bushels of wheat have been obtained, averaging 12 bushels a year

Thus, legumes without lime increased the average yields by 1½ bushels of corn and three bushels of wheat; and legumes with lime increased the average yields by 12½ bushels of corn and nine bushels of wheat. Phosphorus and potassium have further increased the yield of wheat, but not sufficiently as yet to justify their use when all crops grown are considered.

Some pot culture experiments conducted with soil from worn sloping timber land in Henry County furnish results that still further emphasize the need of nitrogen in this class of soils. It should be understood that pot cultures are carried on under perfect control and with almost ideal conditions for the highest yields possible with the soil used.

Oats were grown in these pot cultures and they yielded at the rate of 21 bushels per acre on untreated soil. With potassium applied the rate of yield was 23 bushels, with phosphorus 31 bushels, and with nitrogen applied the rate of yield was 225 bushels of oats per acre.

Sand soils are also markedly deficient in nitrogen as a rule. On the Green Valley soil experiment field in Tazewell County, as an average of three tests each year, nitrogen produced 31 bushels per acre increase in corn in 1902 and 43 bushels increase in 1903; also an increase of 27 bushels of oats per acre in 1904 and 18 bushels of wheat per acre in 1905; and in 1906 four plots not receiving nitrogen yielded 18 bushels, 10 bushels, 8 bushels, and 18

bushels, respectively, of corn per acre, while four other adjoining or intermediate plots, whose treatment differed from the first four only in the application of nitrogen, produced, respectively, 63 bushels, 71 bushels, 75 bushels, and 66 bushels of corn per acre.

On similar adjoining land, where nitrogen had been supplied only by growing and turning under cowpeas, four plots produced 58 bushels, 43 bushels, 46 bushels, and 54 bushels of corn per acre, respectively.

Soils Deficient in Potassium

Peaty swamp lands are commonly exceedingly rich in nitrogen, well supplied with phosphorus, but very deficient in potassium. On the Momence soil experiment field, in Kankakee County, corn has been grown every year for five years on one series of plots. Three plots in this series not treated with potassium have produced 14.3 bushels, 10.0 bushels, and 10.6 bushels, respectively, of corn per acre as a total for the five crops, the average annual yield being 2.4 bushels per acre of corn of very poor quality. On three adjoining plots of similar land, whose treatment differed only in the application of potassium, the total corn produced in the five crops is 221.9 bushels, 242.8 bushels, and 233.7 bushels, respectively, thus making an average annual yield of 46.6 bushels of corn per acre.

As an average of the five years at 35 cents a bushel for corn the average annual net value of the increase produced by potassium amounts to $12.06 an acre after paying for the cost of the potassium applied.

While peaty swamp lands are very abnormal in composition, they are abundant in northern Illinois, and their improvement with the use of potassium is becoming quite general. Indeed the annual profits from the use of potassium on these peaty swamp lands in Illinois is already known to be far above the total annual appropriation for the investigation of Illinois soils.

But of far greater interest and importance to Illinois are the results obtained from the improvement of the ordinary prairie and upland timber soils, representing the most abundant soil types of the state.

Counting 35 cents a bushel for corn, 25 cents for oats, 70 cents for wheat, and $6.00 a ton for clover hay, for the increases produced in these crops by the different elements of plant food applied, we may summarize in a very brief and satisfactory manner the results thus far secured from a sufficient number of the soil experiment fields on these important soil types to furnish a clear understanding and a reliable basis of opinion concerning the relative and actual value of these plant food elements during the first five years.

Methods of Soil Investigation

It should be understood that most of the results reported in this paper have been secured from what we term "complete fertility" experiments, which were designed for the one purpose of securing information as quickly as possible concerning the needs of the soil.

Thus, in order to learn quickly and certainly if the soil needs more nitrogen we have applied nitrogen liberally in one of the best and most expensive forms. Other experiments are in progress to ascertain how rapidly and how economically we can secure nitrogen from the air by legumes in crop rotation.

Again, in order to learn if the soil needs phosphorus we have applied phosphorus in steamed bone meal, which is known to furnish it in a very good and readily available form, although at three times the cost of natural rock phosphate. Other experiments are in progress to ascertain how rapidly we can make rock phosphate available under various conditions.

We have also applied the element potassium in the ordinary commercial salts, as potassium sulfate, and potassium chlorid, in order to learn if this element of plant food applied in readily available form will increase our crop yields. Other experiments are being carried on with the hope of ascertaining the best methods of liberating sufficient

potassium from the immense supply naturally contained in most soils.

It will be understood then that while the information already secured, both by soil analysis and by pot cultures and field experiments, shows conclusively that certain soils are deficient in certain plant food elements and that the addition of these elements produces large increases in crop yields, the investigation is by no means complete as to the most profitable means of supplying these different plant food elements in systems of permanent agriculture.

If the total supply of any element in the soil is limited, as is the case with nitrogen and phosphorus in most soils, it seems certain that no system of agriculture can be permanently successful unless we return to the soil as large or larger amounts of that element as we remove in crops. It is because of this apparently self-evident fact that our standard application of phosphorus is slightly more than the amount removed in very large crops, so that under this treatment the soil must grow richer and richer in phosphorus.

One other very important point should always be kept in mind in considering the effect of soil treatment on crop yields. This is the fact that the material in which the plant food element is applied may produce an indirect effect which may cause an increase in the crop yield not due to the element in mind for its own sake, but due to some stimu-

lating action of the applied substance upon other elements already in the soil. Soluble salts, such as sodium nitrate, acid phosphate, and potassium salts, are known to produce some very marked indirect or stimulating effects, similar to the effect of that powerful soil stimulant, landplaster. Materials used for this purpose which do not supply in themselves the deficient plant food element in sufficient amount to fully meet the needs of the crop are to be used with caution and with full understanding that they tend to make the soil poorer and poorer in the element liberated. Light and infrequent applications of farm manure and only occasional crops of clover act to a greater or less extent as soil stimulants, if they liberate plant food from the soil, and thus enable the crops to remove much larger amounts of fertility than are actually supplied by the manure or clover.

In the case of nitrogen and phosphorus we have tried to avoid these indirect or stimulating effects by using dried blood and steamed bone meal in place of any soluble salts, as sodium nitrate and acid phosphate, which are very commonly used for such experiments; but there is no satisfactory insoluble readily available form of potassium, and consequently we could not avoid using a soluble potassium salt. Thus, in considering the results reported below, we may have confidence that the effects produced by nitrogen and phosphorus are properly to be credited to those elements for their

own value as plant food, but the effects on crop yields produced by potassium salts applied to soils naturally rich in that element are undoubtedly due in part at least to an indirect or stimulating action.

The actual cost per acre per annum for the materials used in these complete fertility experiments is about $15 for 100 pounds of nitrogen in dried blood, $2.50 for 25 pounds of phosphorus in 200 pounds of steamed bone meal, and $2.50 for 40 pounds of potassium in 100 pounds of potassium sulfate. Thus, for five years the cost per acre is $75 for nitrogen, $12.50 for phosphorus, and $12.50 for potassium.

Soils Deficient in Phosphorus and Nitrogen

On the Antioch soil experiment field, in Lake County, on timber soil, where nitrogen has been applied in dried blood the value of the increase in five years amounts to $6.04 an acre; where phosphorus has been applied in steamed bone meal the value of the increase is $33.73 an acre in five years; and where potassium has been used in addition to both nitrogen and phosphorus, under the most favorable condition, the value of the increase by potassium is $12.12.

On the Bloomington soil experiment field, in McLean County, on prairie soil, the increase produced by nitrogen alone is worth $1.77 in five years; where bone meal was applied the value of increase by phosphorus is $22.77; and where

potassium was applied, under the best conditions, the increase in crops was worth $10.50.

Of greatest interest is the increase produced on this typical corn belt land where both nitrogen and phosphorus were provided. This amounted to $36.49 in five years. These results show that this soil needs both phosphorus and nitrogen, but it needs phosphorus first. Thus, the nitrogen without phosphorus was worth only $1.77, but in addition to phosphorus the nitrogen was worth $13.72 an acre in five years. On the other hand, the phosphorus alone was worth $22.77; but when used with nitrogen the phosphorus was worth $34.72 above what the nitrogen alone was worth.

In a somewhat different rotation on the Sibley soil experiment field in Ford County, on prairie land, the value of increases produced in five years has been $2.45 for nitrogen, $12.99 for phosphorus, $27.47 for nitrogen and phosphorus together, and 20 cents for potassium when applied in addition to nitrogen and phosphorus.

Phosphorus and Clover

As was anticipated when these experiments were begun, we are securing information more rapidly where we are applying nitrogen in commercial form at an annual cost of $15 or more per acre than where we depend entirely upon legume crops grown in the rotations. While phosphorus is usually the most deficient element in the prairie soils, that ele-

ment cannot increase the yield more than 10 to 20 bushels as a rule until nitrogen becomes the limiting element; and where we use phosphorus without nitrogen the nitrogen limit of yield grows lower and lower until ultimately it sinks below the phosphorus limit, after which phosphorus has no power to increase the yield until the supply of nitrogen is increased. The very marked increase in clover produced by phosphorus is due to the fact that for this crop there is no nitrogen limit because if the available soil nitrogen is insufficient the clover plant can draw upon the atmospheric nitrogen for enough to balance its own ration.

Thus, on the Bloomington field in 1906, phosphorus increased the yield of clover from .58 ton to 1.65 tons, a gain of 1.07 tons per acre by phosphorus; and, as an average of the last three years on the experiment field at Urbana, phosphorus has increased the yield of clover from .73 ton to 1.75 tons per acre, the gain for phosphorus being more than one ton of clover hay per acre as an average of three successive years, all weights reported being for thoroughly air-dried hay (not merely field cured).

The importance of phosphorus and clover is very well illustrated by considering the yields from two plots in the three-year rotation on the university field at Urbana, which differed in yielding power by only three bushels of corn per acre as an average of three years previous to the beginning of treat-

ment. One of these plots has been receiving phosphorus since 1902, while the other receives no phosphorus. Otherwise the two plots are treated alike in every respect.

In 1903, the yields of corn were 71 bushels and 84 bushels, making 13 bushels in favor of the phosphorus-treated plot.

In 1904, the yields of oats were 48 and 60 bushels, a gain of 12 bushels for phosphorus.

In 1905, the yields of clover were .87 and 1.83 tons of thoroughly air-dry hay, a gain of .96 ton, showing that the phosphorus more than doubled the yield.

In 1906, corn was again grown on these plots and it was to be expected that the corn would be benefited, not only by the phosphorus applied, but also because of the larger amount of clover roots and residues left on the phosphorus plot. The yields of corn in 1906 were 58 and 84 bushels, a difference of 26 bushels in favor of the phosphorus plot. The value of the increase for the four years is $22.41, while the phosphorus cost only $10 in steamed bone meal, and the same amount of phosphorus can be purchased in raw rock phosphate for $3.20.

On the Virginia soil experiment field in Cass County, nitrogen is already the limiting element, being more deficient than phosphorus.

The value of the increase produced by nitrogen in five years is $6.94; that by phosphorus alone is only $1.78, but where nitrogen and phosphorus

are applied together the increase is worth $13.89. Potassium produced $4.00 worth of increase under the most favorable conditions.

It is known that the untreated check plots on the Virginia field were somewhat better than the other plots in the field when the experiments were begun. This has been a rather heavy handicap against the soil treatment, although the treated land has overcome this handicap and made some additional gains, as shown by the data given.

If we consider nitrogen under the most favorable conditions, as we have regularly done with potassium, we shall probably have a more trustworthy opinion of its importance on the Virginia field. Where nitrogen has been applied in addition to both phosphorus and potassium, the value of the increase by nitrogen is $31.80 an acre from the five crops.

Soil Problems in Southern Illinois

If we turn to the experiment fields on the Southern Illinois prairie lands, we may summarize the results in a similar manner, but we shall find additional problems peculiar to those soils, some of which will doubtless require much further investigation for correct and final solution.

First of all we should emphasize the fact that the common soil in this great area is acid, or sour, and that some form of lime must be applied to the land in liberal amount as a part of any system of im-

provement for this soil, especially for the benefit of clover and other legume crops which are so essential in good crop rotations.

Ground limestone promises to be both the best and the most economical form of lime for this purpose, and definite arrangements have already been made, under the direction of the Governor and the Board of Prison Industries, to have the State furnish this material to the farmers at cost.

Information thus far secured indicates that finely ground limestone will be delivered at the railroad stations in Southern Illinois at a cost varying from $1.00 to $2.00 a ton, that two to four tons per acre will be sufficient for an initial application, and that 50 cents an acre a year should be ample to provide for subsequent applications sufficient to keep the soil sweet.

As an average of 56 tests made during the past three years on crop rotations including cowpeas, clover, corn, oats, and wheat, the average annual value of the increase in crop yields from the use of lime or limestone on these soils has been more than five times this estimated average annual expense.

These soils are not only deficient in lime, but they are also very deficient in phosphorus and in decaying organic matter needed to make available for plant growth the potassium and other mineral elements naturally contained in the soil in very large quantities, also to keep the phosphorus in

available combination, and ultimately, of course, to furnish nitrogen, which, however, at present is less effective when applied than either phosphorus or potassium, as will be seen from the data given.

As an average of duplicate tests on the Du Bois field in Washington County, nitrogen alone has produced $2.19 increase in five years; the increase from phosphorus in bone meal has been $20.74; while potassium applied under the most favored conditions, has produced increases valued at $9.93.

It is noteworthy, however, that the effect of potassium on certain very important crops, as corn, clover, and cowpeas, is more marked in the later years; and it is becoming evident that until we are able to increase the supply of decaying organic matter in those Southern Illinois prairie soils, we may find some profit in using potassium, best supplied in kainit, perhaps, probably for its combined effect as plant food and as a soil stimulant, possibly serving in part to make phosphorus more available under the existing conditions.

In this special connection, the results obtained from the use of potassium salts and of other salts as well in investigations extending over half a century at the Rothamsted Experiment Station are of great interest and value:

Where wheat was grown continuously without organic manures, the yield was increased 5.6 bushels per acre, as an average of the first 24 years, by the application of 200 pounds per annum of po-

tassium sulfate. This might seem to be conclusive proof of the need of potassium in the Rothamsted soil, but such was not indicated by the soil analysis. Furthermore, when, instead of the potassium sulfate, an application of 280 pounds of magnesium sulfate was substituted, exactly the same increase was produced as an average of the 24-year period.

During the second 24-year period the potassium salt increased the average yield by 8.8 bushels, while the increase by magnesium sulfate was only 6.6 bushels.

In the case of barley grown continuously on the same land for 48 years, the application of sodium salts without potassium produced a larger average increase than when potassium was included in the application.

These results certainly emphasize the fact that the effect produced by potassium salts on lands rich in native potassium may be due largely at least to its power as a soil stimulant and that the same effect may be secured by applying other less expensive soluble salts or probably still more economically by means of decaying organic matter, which, however, must be first produced before it can be turned under.

On the Cutler experiment field in Perry County, nitrogen has produced no increase; phosphorus alone in bone meal has made only $4.85 in five years; while potassium used alone has returned only $1.23 in the five years.

Under the most favored conditions for each element in turn, nitrogen has produced no gain, phosphorus a gain worth $15.54, and potassium a gain worth $13.82. When phosphorus and potassium were used together the gain was $25.56 per acre in five years, when applied in bone meal and potassium sulfate.

Some extensive experiments are in progress on this soil in which these elements are brought together at much less expense, the phosphorus being supplied in rock phosphate and the potassium in smaller amount in kainit, which, however, also carries some other salts which may produce the indirect or stimulating effect. The object of this as of other soil investigations is to find some system of permanent agriculture that shall also be profitable on this Southern Illinois soil, and it is to be hoped that the use of this soluble fertilizer and stimulant can soon be replaced by manure or other organic matter from the increased crops.

On the regular rotation field at Cutler where nitrogen is secured only by growing legumes, the five-year increase by phosphorus and potassium together is $18.34, of which $9.12 were secured during the first three years, while $9.22 were secured during the last two years.

Likewise on the Odin soil experiment field in Marion County, the average increase for the first three years does not pay for the cost of treatment, but the increase produced on three series of plots

during the last two years on two crops of corn, two of wheat, one of cowpeas, and one of clover, slightly more than paid the cost of the bone meal and potassium sulfate.

The average yields produced on these best treated plots were 57 bushels of corn, 33 bushels of wheat, 1.3 tons of clover, and 2.4 tons of cowpea hay.

On one division of the Edgewood soil experiment field in Effingham County, where the land has been tile-drained for six years, and where the soil has been treated with one application of ten tons of ground limestone and the regular amounts of phosphorus and potassium, the following yields have been secured:

Clover, 2.69 tons per acre in 1904;
Corn, 87 bushels per acre in 1905;
Oats, 73 bushels per acre in 1906.

The value of the increase produced by the lime, phosphorus, and potassium, over the untreated land, is $17.96 for the last three years, averaging $5.99 per acre per annum.

It should be understood that the present value of this land is at least $100 an acre less than that of the ordinary corn belt land; that with proper treatment this land should continue to improve, and with the crops now being produced considerable manure will be made which can be returned to the land to further increase the crop yields and

at the same time permit some decrease in the purchase of commercial plant food, especially of potassium.

Furthermore, it should be kept in mind that systems of soil improvement must be adopted even for the corn belt land in order to maintain its present value and productive power.

Time will not permit the discussion of other Southern Illinois problems concerning which we have some information and need very much more, including the effect and feasibility of tile drainage and subsoiling, the special value of farm manure on these lands, and the crops and crop rotations best adapted to the profitable improvement of Southern Illinois soils.

Permanent Agriculture on Every Farm

In conclusion, I beg to repeat a suggestion which I made at your annual meeting four years ago, to the effect that every landowner adopt a system of permanent soil maintenance or of soil improvement on at least an acre strip of land across every important cultivated field, making his plan for this from his own knowledge combined with all of the information obtainable from the soil experiment fields and other soil investigations.

Whatever treatment is decided upon should be applied and repeated with every rotation with any modifications justified by accumulated knowledge and results, until it is demonstrated upon the

individual farm that there are systems of permanent profitable agriculture of unlimited application that can be practiced in Illinois.

When making these plans for our most common normal prairie lands in Northern, Central, and Southern Illinois, it may well be kept in mind that our three greatest problems are:

(1) To secure nitrogen from the inexhaustible supply in the air.

(2) To liberate potassium from the practically inexhaustible supply in the soil.

(3) To return phosphorus to the soil in some form in as large or larger amounts than are removed in crops.

Through the courtesy of Professor Hopkins, I have given his experiences in scientific farming. Professor Hopkins is doing a great work, and striving to arouse the farmers to a better cultivation of their land, and he fully realizes the importance of a better system of farming.

LIBRARY OF CONGRESS
0002586286 7